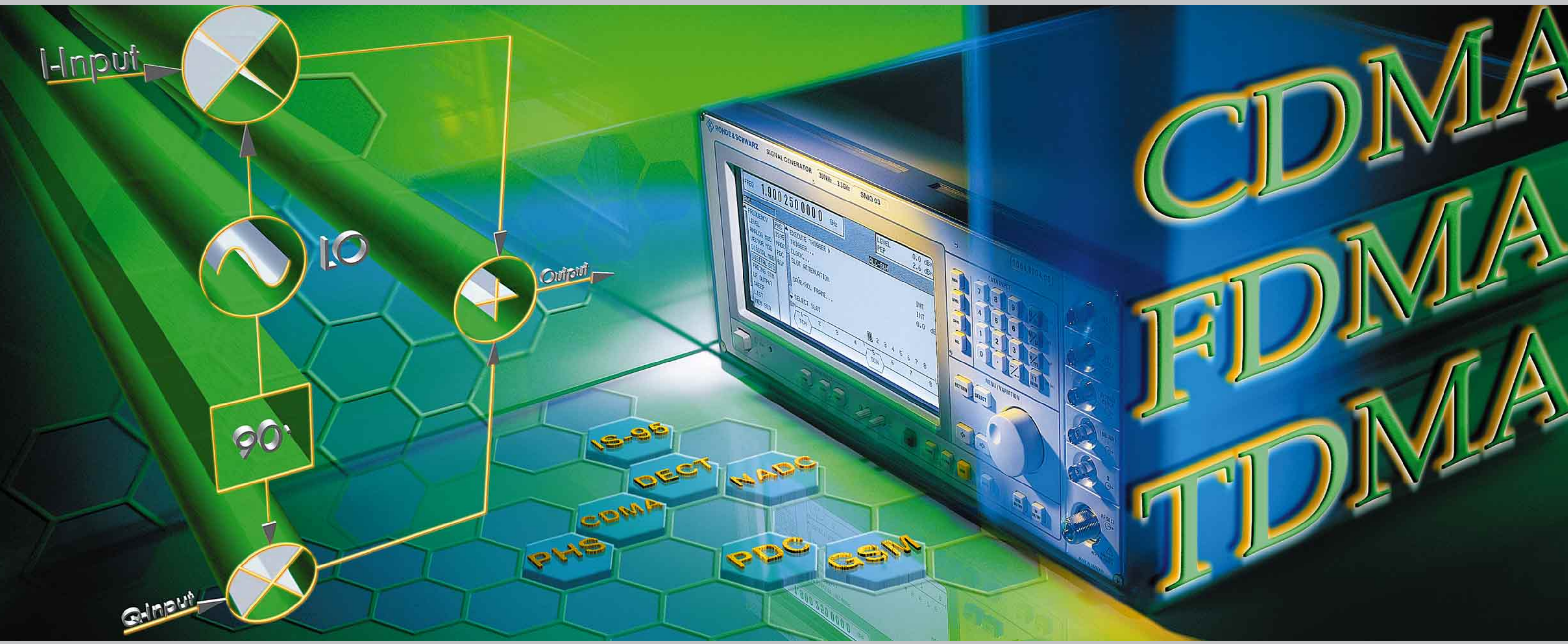
News from Rohde & Schwarz



Signals up to 3.3 GHz
with digital and analog modulation

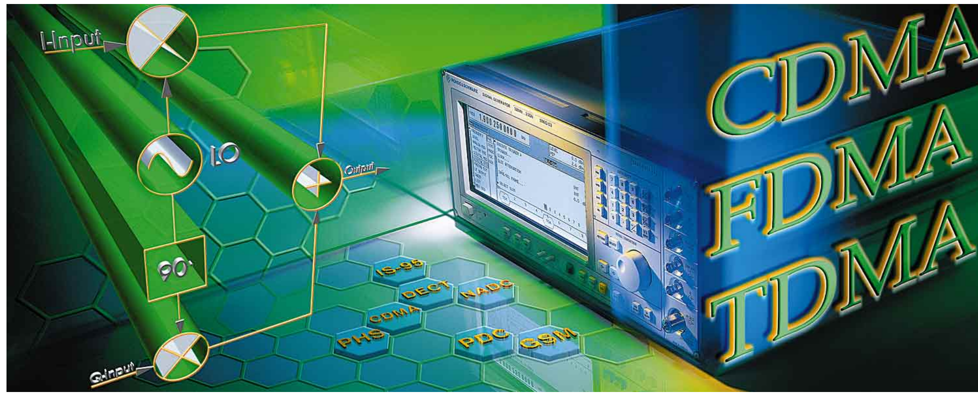
ATC radiocommunications
VHF-UHF multichannel radio equipment

Broadband communications
Digital TV signals for cable headends

1997/II
154

ROHDE & SCHWARZ

Number 154 1997/II Volume 37



Signal Generator SMIQ features the classic modulation modes AM, FM and φM plus I/Q, burst, pulse and broadband amplitude modulation up to 3.3 GHz. This makes SMIQ an unrivalled signal source for mobile radio, digital audio and video broadcasting as well as other broadband systems (page 4). Photo 42 814/1

Articles

Application notes

For LGGA in Liechtenstein Rohde & Schwarz has set up a cable headend system with the main station in Vaduz and two remote receiving stations. The system is made up of components of CATV Headend System CT200 and supplies the whole country with a great variety of sound and TV programs (page 34). Photo 42 828/1

Software

Refresher topic

Panorama

Regular features

Automatic measurements of RFI voltage, RFI power and RFI field strength according to CISPR and VDE are performed at a keystroke by EMI Test Receiver ESCS30 from 9 kHz to 2.75 GHz; its main field of application: certification, precertification tests and development support (page 7).
Photo 42 781

Imprint

Published by ROHDE & SCHWARZ GmbH & Co. KG Mühldorfstraße 15 D-81671 Munich Telephone (0 89) 41 29-0 · international *(4989) 41 29-0 · Telex 523703 (rs d) · Editors: H. Wegener and G. Sönnichsen (German); G. Koranyi, C. B. Newberry (English) · Photos: S. Huber · Artwork: Nike Hofmann · Circulation 100 000 four times a year · ISSN 0028-9108 · Supply free of charge · State company or position · Printed in the Federal Republic of Germany by peschke druck, Munich · Reproduction of extracts permitted if source is stated and copy sent to R & S Munich

Signal Generator SMIQ

High-quality digital modulation up to 3.3 GHz

Vector Signal Generator SMIQ represents a new generation of signal generators from Rohde & Schwarz with digital modulation capability. SMIQ also features precise I/Q modulation for broadband communication applications, short measurement times through fast synthesis and a large dynamic range thanks to its high spectral purity. Plus SMIQ comes with a real innovation: its fading simulator option allows predefined 6- or 12-path fading.

FIG 1 Signal Generator SMIQ, universal RF source for research, development and production in digital mobile radio Photo 42 814/2

SMIQ is a signal generator capable of digital and analog modulation for use in the development and production of digital mobile-radio receivers and components as well as for general-purpose measurements (FIG 1). Its frequency range covers all common mobile-radio frequencies and applications in the IF range. The generator comes in four models: SMIQ02, SMIQ03, SMIQ02E and SMIQ03E. The figures 02 and 03 stand for the upper frequency limits of 2.2 GHz and 3.3 GHz respectively. E signifies an economy model.

Models SMIQ02 and SMIQ03 feature high-quality I/Q modulation combined with extremely low phase noise. The synthesizer is of high spectral purity, ensuring excellent phase stability, which further enhances vector modulation quality. High-grade vector modulation need not be at the cost of economy however. This is convincingly demonstrated by the SMIQ economy models. They offer favourably priced, high-quality instruments for entry to the field of I/Q measurements.

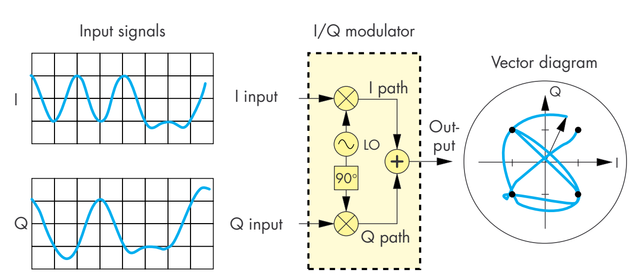
All models feature the classic modulation modes AM, FM and φM plus vector modulation (analog I/Q modulation), burst, pulse and broadband amplitude modulation. Among these modulation modes, vector modulation is of paramount importance. With a baseband width of 30 MHz, vector modulation enables generation of complex modulation signals for the RF carrier at bandwidths up to 60 MHz. This allows applications not only in mobile radio but also in the field of DAB (digital audio broadcasting), DVB (digital video broadcasting) and for other broadband systems including spread spectrum, eg CDMA (code-division multiple access).

Complete solutions for customer benefit

SMIQ comes with a number of powerful options for optimum adaptation to customer's requirements. This does away with the need for extra measuring equipment and the development of customized solutions. The advantage is obvious: time and cost are minimized if complete systems with calibrated test signals can be readily supplied to the user. Available options include a modulation coder and a data generator for all models, and additionally a fading simulator for models SMIQ02 and SMIQ03.

The modulation coder supplies filtered baseband signals for driving the I/Q modulator. Digital modulation formats 4FSK, GFSK, GMSK, BPSK, 8PSK, QPSK, OQPSK, π/4 DQPSK and 16QAM through 256QAM can be selected with clock rates up to 7.5 Msymbol/s. The data generator supplies the corresponding data sequences and control signals for generating the frame structure required for mobile-radio networks. The range of options is completed by a fading simulator. Fitted with this, SMIQ generates faded test signals in line with specifications with a calibrated level at a keystroke, as it were, which is a truly unique feature. Anyone who has set up a customized test system made up of individual instruments knows the effort involved and will appreciate this all-in-one solution.

FIG 2 Block diagram of I/Q modulator of SMIQ as well as I and Q input signals and I/Q diagram for QPSK modulation



I/Q modulation

Digital modulation techniques use filtered phase and/or amplitude shift keying. These complex forms of modulation can be generated by an I/Q modulator with high precision. The latter, also known as a quadrature modulator, modulates orthogonal I and Q (in-phase and quadrature phase) components on an RF signal (FIG 2). An LO (local oscillator) supplies a signal to the mixer of the I path and, via a 90° phase shifter, also to the mixer of the Q path. The two mixers effect amplitude modulation of the 0° and 90° components of the RF signal. With appropriate signals applied to the IF inputs of the mixers (I and Q inputs), the I and Q components can be modulated as required. The two components are added to form an output signal that can be modulated in amplitude and phase as required. The example in FIG 2 shows the characteristic of a carrier vector in an I/Q diagram for QPSK modulation with the corresponding I and Q input signals.

A basic requirement for low error vector in digital modulation is a highly accurate I/Q modulator. So particular importance was attached to this feature in developing SMIQ. But there are other requirements. Spectral purity of the synthesizer is of equal importance as phase errors also affect the error vector. How this has been implemented is demonstrated impressively by models SMIQ02 and SMIQ03. Economy models SMIQ02E and SMIQ03E also offer extraordinarily high vector accuracy. The rms value of the error vector of SMIQ is 0.3%, that of the economy models 1%. FIG 3 shows as an example the error vector of SMIQ03 for the duration of a burst for NADC (North American digital cellular).

Another important criterion for the quality of an I/Q modulator is intermodulation. Besides synthesizer phase noise, it is intermodulation that determines adjacent-channel power in digital modulation. The high linearity of the I/Q modulator in conjunction with the high spectral purity of models SMIQ02 and SMIQ03 yields accuracy that even meets the stringent requirements for adjacent-channel selectivity measurements in the first adjacent channel for TETRA (trans-European trunked radio). FIG 4 demonstrates the spectral purity of a TETRA signal generated by SMIQ03. The measurement reveals adjacent-channel power of −71dBc at a spacing of 25 kHz for externally applied I/Q signals.

The I/Q modulator is also ideal for amplitude modulation incidentally. Apart from large modulation bandwidth, it features extremely small incidental φM with AM. These characteristics can be utilized in a very convenient way by means of the broadband AM setup menu implemented in SMIQ.

Digital modulation

The modulation coder option of SMIQ allows simple generation of digital modulation signals from digital input signals. By means of the built-in mapping function (which allocates the states in the I/Q diagram to the symbols) and adjustable digital filters, the input signals are converted into analog I and Q voltages driving the I/Q modulator. Selectable modulation formats, baseband filters and symbol rates are shown in the blue box. Apart from the standard settings shown below, user-defined values for the mapping and baseband filters can be loaded into SMIQ. This is particularly useful if new standards are created that deviate from previously used formats and filters. External baseband signal processing thus becomes superfluous in most cases.

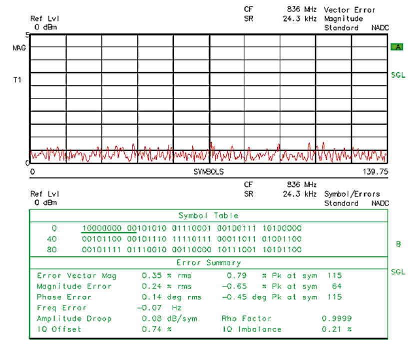


FIG 3 Error vector over burst in NADC

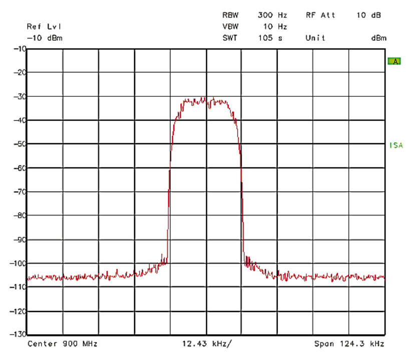


FIG 4 Spectrum of TETRA signal generated by SMIQ

The input interface was designed for high versatility of SMIQ. The modulation coder accepts digital input signals both in the form of serial bit-clocked bit streams and as up to 8-bit-wide symbol-clocked parallel data. The inputs can be configured as CMOS, TTL and ECL interfaces and terminated with 1 kΩ or 50 Ω. But SMIQ is not only capable of modulating external signals. The data generator option allows convenient, internal generation of user-defined data sequences and loading of stored sequences.

Modulation format	Baseband filter	Symbol rate
4FSK	$\sqrt{\cos}$ (α = 0.15 to 0.7), cos (α = 0.15 to 0.7) Bessel Filter	1 kHz to 2.5 MHz
GFSK, GMSK	Gaussian $B \cdot T$ = 0.2 to 1	1 kHz to 2.5 MHz
BPSK, QPSK, OQPSK, π/4 DQPSK, 8PSK	$\sqrt{\cos}$ (α = 0.15 to 0.7), cos (α = 0.15 to 0.7)	1 kHz to 7.5 MHz
16, 32, 64, 256QAM	$\sqrt{\cos}$ (α = 0.15 to 0.7), cos (α = 0.15 to 0.7)	1 kHz to 7.5 MHz

Standard settings at a keystroke

The advantages of ready programmed frame and data structures for standard measurements are known to everyone who ever programmed data bit by bit for BER measurements on receivers. What makes this so difficult is not only the tiresome programming of test equipment bit by bit but also the fact that this task requires detailed knowledge of network data structure. These difficulties are a thing of the past. With its data generator option, SMIQ offers a choice of standard settings for various networks (presently PHS, CDMA IS95, NADC, PDC) at a keystroke. Operation

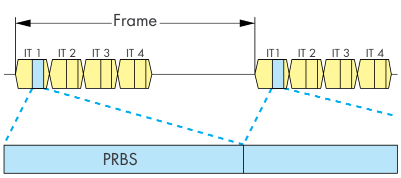


FIG 5 SMIQ allows continuous data sequences without any losses to be inserted into data blocks of time slots.

is extremely easy and requires no network-specific knowledge. Operator convenience is enhanced by a large high-contrast LCD and menu control allowing setups to be loaded and both data and frame structure to be graphically displayed. In addition, the data generator allows data sequences to be inserted into the data blocks of TDMA (time-division multiple access) slots so that they are continued without interruption in the next frame, as illustrated by FIG 5. This characteristic is needed, for example, in BER (bit error rate) measurements to evaluate receiver sensitivity. For such measurements a continuous PRBS (pseudorandom bit sequence) data stream must be sent in the data blocks.

To generate the correct signals for TDMA, which is frequently used in digital modulation, a further type of modulation, ie envelope modulation, is required to generate the power bursts. On/off switching of the RF power in a TDMA time slot must have a special characteristic so that other mobile-radio subscribers are not disturbed. On the one hand the edge must not be too slow to avoid interference with adjacent time slots, on the other hand the edge must not be too fast to avoid interference from the generated spectral components on adjacent frequency channels. SMIQ, fitted with data generator and modulation coder, generates as standard a power ramp characteristic that meets the requirements both in the time and frequency domain.

CDMA (code-division multiple access) systems, in contrast to TDMA systems, transmit several channels at the same time and at the same frequency, separated by codes. This places high demands on the amplifiers used. Summation of the CDMA channels yields an output signal with a high crest factor. The latter is the ratio of the peak value to the rms value of the signal. The amplifiers, therefore, must be highly linear as nonlinear distortion would give rise to intermodulation products in the adjacent frequency channel. To check linearity, SMIQ offers a convenient function allowing up to 18 code channels to be set in line with IS95. The levels can be set separately for the pilot, sync and paging channels and jointly for the remaining traffic channels.

The all-important speed factor

SMIQ was developed with a special view to the current trend towards high measurement speed. Apart from fast frequency setting, which has always been a strong point of Rohde & Schwarz signal generators, SMIQ now also features fast level control. This is of advantage not only in the measurement of adjacent time-slot suppression with levels of up to 50 dB being switched between neighbouring slots, but also in RSSI (receiver signal strength indicator) calibration of receivers. During calibration, calculated level settings are called up one by one in the list mode, the setting time in this mode being smaller than 500 μs.

Whether standard or special-purpose measurement, the user will benefit from SMIQ in a variety of ways. Great operating ease, preprogrammed standard settings, high signal quality, short measurement times – all these features will help the user get the job done fast.

Johann Klier

Condensed data of Signal Generator SMIQ

Frequency range	
SMIQ02 / SMIQ02E	300 kHz to 2.2 GHz
SMIQ03 / SMIQ03E	300 kHz to 3.3 GHz
Frequency setting time	
SMIQ02 / SMIQ03	<15 ms (<500 μs in list mode)
SMIQ02E / SMIQ03E	<25 ms
Spurious (carrier offset 10 kHz to 300 MHz)	<–70 dBc
SSB phase noise (f = 1 GHz, carrier offset 20 kHz)	
SMIQ02 / SMIQ03	<–123 dBc
SMIQ02E / SMIQ03E	<–113 dBc
Level range	–144 to 13 dBm
Analog modulation	AM, FM, φM, BB-AM, vector, burst, pulse modulation
Digital modulation	4FSK, GFSK, GMSK, BPSK, 8PSK, QPSK, OQPSK, π/4 DQPSK, 16, 32, 64, 256QAM

Reader service card 154/01

EMI Test Receiver ESCS30

Top in full-compliance testing

The highlights of EMI Test Receiver ESCS30: frequency range from 9 kHz through to 2.75 GHz in one compact, favourably-priced instrument, complete with VGA colour display and macros for automatic testing, which makes an external process controller mostly superfluous.

FIG 1 EMI Test Receiver ESCS30 (9 kHz to 2.75 GHz) is a high-end EMC measurement instrument for certification, precertification and development. Photo 42 783

Even in its basic version EMI Test Receiver ESCS30 – an important extension to the worldwide successful ESHS/ESVS/ESS family [1] – is a full-compliance test receiver to CISPR and VDE. It performs EMC measurements to standards with outstanding precision, immunity to overload, dynamic range and selection (FIG 1). The built-in time domain analysis allows examination of interference versus time. When used for precertification testing of electrical equipment at the development stage, ESCS30 detects critical frequencies and serves for product optimization [2]. This reduces development and manufacturing costs, increases price calculation reliability and makes for a successful product.

Automatic tests at a keystroke

At a single keystroke ESCS30 performs complete **RFI voltage, RFI power and RFI field-strength measurements.** It determines the critical ranges of the spectrum by a prescan measurement using the peak detector. The Max. Hold function allows intermittent interference to be detected. Data-reduction routines serve for determining the frequencies for the final measurement, which is then carried out by means of the quasi-peak and/or average detector with standard-conforming measurement time. This concept saves valuable time that would otherwise be wasted on examining frequency ranges with low emission levels.

The test receiver automatically selects the correct CISPR bandwidth for the specific test frequency and makes comparisons with limit lines, eg to EN standard. In case of RFI voltage measurement the phase settings of the line-impedance stabilization network (LISN) are automatically set. The phase with the highest RFI level is used for final measurement and recorded. For RFI power measurement ESCS30 interactively searches for the interference maxima. For RFI field-strength measurement the highest emissions are also determined interactively and recorded.

Simple test assemblies for all types of analysis

To perform measurements to EN standards the following basic equipment is required:

RFI voltage measurement
EMI Test Receiver ESCS30, LISN (2-line or 4-line V network), printer/plotter

RFI power measurement
EMI Test Receiver ESCS30, absorbing clamp (if necessary, slideway for automatic guidance of clamp), printer/plotter

RFI field-strength measurement
EMI Test Receiver ESCS30, antennas (magnetic/electrical/electromagnetic), tripod/mast for fixing the antenna, printer/plotter (FIG 2)

RF analysis can be operated in the Spectrum Overview, Scan and Channel Scan modes.

In the **Spectrum Overview** mode a fast measurement is made of the spectrum between start and stop frequency according to a user-selectable scan table. The minimum measurement time is 50 µs per result and the RF attenuation is

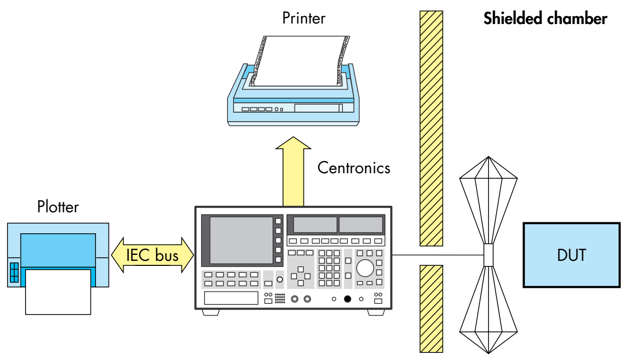


FIG 2 Test setup for RFI field-strength measurements

preselected. The step size of frequency switching is coupled to the selected IF bandwidth and ensures continuous monitoring of the frequency range. The tracking preselection remains active in the Spectrum Overview mode and ensures the necessary immunity to overload. This type of overview measurement can be switched to continuous scan for qualitative assessment of the spectrum.

In the **Scan** mode a standard-conforming measurement is again carried out on the basis of a user-selected scan table. The measurement, however, uses selectable step widths in a linear or logarithmic frequency raster. The switchable autoranging function increases the dynamic range and prevents measurement errors that can be caused by overload of the different receiver stages. To reduce the measurement time, peak and average value can be measured simultaneously and displayed as separate traces. CISPR ranges A, B, C and D are predefined as scan ranges and can be activated at a keystroke.

The **Channel Scan** mode is used if measurements have to be made time and again on the same frequencies as is the case with ready tested DUTs where a scan would not yield any new results. The Channel Scan comprises a list of up to 400 different frequencies at which the level is measured using the selected receiver settings such as measurement time, bandwidth and detector.

The **time domain analysis** of ESCS30 allows the time behaviour of interference to be determined. It is also very expedient for correct setting of receiver measurement time for RF analysis. The user can determine whether narrowband interference fluctuates and the degree of fluctuation, and whether it is amplitude-modulated. Furthermore the pulse rate of broadband interference can be measured. The measurement time is correct if it is greater than or equal to the reciprocal value of the pulse rate. Devices with thermostatic or microprocessor control generate discontinuous interference. Therefore CISPR14 and EN55014 specify limit values for the RFI voltage with click-rate weighting in the range 0.15 to 30 MHz. Click interference frequently occurs only at long time intervals. In the course of time domain analysis with a peak detector ESCS30 allows the signal to be measured with quasi-peak and average detector. Together with the internal trigger that starts the measurement only when a selectable threshold is exceeded, this combination affords time-saving automatic measurement with clear result display (FIG 3). The time domain analysis with resolution of 100 µs meets the accuracy requirements for pulse-duration measurements. Up to 30,000 results can be stored and zoomed with the marker function for detailed investigation.

An important tool for identifying signals in the receive frequency range is **IF spectrum analysis** with realtime display. A display range between 10 kHz and 10 MHz is selected for the chosen receive frequency and the signal is assessed using a resolution bandwidth of 1, 3 or 10 kHz. The strength of IF analysis is in the fast determination of interference signals.

Characteristics and operation

The **outstanding features** of ESCS30 are:

- measurement uncertainty <1 dB (typ. <0.5 dB),
- ten integrated preselectors,
- selectable preamplifier 10 dB,
- CISPR bandwidths 200 Hz, 9 kHz, 120 kHz, 1 MHz,
- detectors (peak, average, quasi-peak) with parallel output of results and bargraph display on colour monitor,
- direct selection of CISPR measurement ranges with bandwidth, step width and measurement time,
- automatic scan of frequency ranges and lists with up to 400 different frequencies,
- automatic level calibration and built-in selftest function,
- macros for RFI voltage, RFI power and RFI field-strength measurements,
- nonvolatile storage of complete instrument setups as well as limit lines and frequency-dependent correction factors of antennas and accessories,
- storage of results, limit and correction values on built-in 3.5″ disk drive,
- time domain analysis with display range from 5 ms to 1 h, manual trigger (internal and external), user-selectable zooming of up to 30,000 measured values,

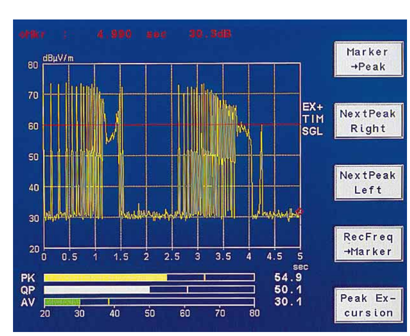


FIG 3 Measurement of click interference in time domain

- IF spectrum analysis with resolution of 1, 3 or 10 kHz over a display range from 10 kHz to 10 MHz (option),
- 9 kHz to 2750 MHz tracking generator (option).

The **operating concept** of ESCS30 makes for great measurement convenience and fast and reliable setting of the receiver. The clear arrangement of the controls – all keys being assigned one function only – and the indication of the selected parameters such as attenuation, bandwidth and detector(s) on separate LC displays ensure great ease of operation. For solving complex EMC problems, manual measurement often is the most efficient way, since the operator can make full use of his experience in identifying interference sources. ESCS30 features the proven test receiver operation with tuning knob, indication of results on an LC display, bargraph and meter as well as acoustic monitoring via the built-in loudspeaker. Marker and zoom functions permit in-depth analysis of interference spectra. The level values of the detectors selected are displayed below the diagram in quasi-realtime as a bargraph with peak-hold indication (FIG 4). The audio section is provided with A0, AM and FM demodulators with squelch enabling acoustic identification of signals via the built-in loudspeaker or a headphones output.

System integration and documentation

The high measurement speed of ESCS30 is also useful for remote control via a fast controller (interface to IEC 625.2/IEEE 488.2). All functions of the test receiver can be remotely controlled and are supported by Rohde & Schwarz EMI software products.

ESCS30 adheres to the standardized report configuration of Test Receivers ESHS/ESVS/ESS so that reports can be compared. A comprehensive test report can be generated on a printer or plotter. It contains all relevant information required for the reproducibility of measurements, such as comments and description, test receiver settings, graphs and final results. All results (scan values as well as test frequencies and level values) can be checked by the user on the monitor prior to producing a printout. Additional comments are entered via the line editor, which in mobile testing allows test runs or parameter sets to be marked and does away with the need for an external keyboard. The final results are output in graphical and tabular form giving levels measured with quasi-peak and average detectors versus frequency. Levels exceeding the limit lines are marked.

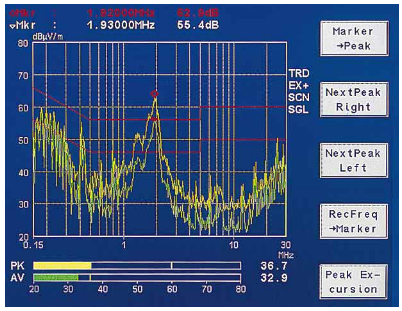


FIG 4 RF spectrum with active markers and bargraph display

Like all full-compliance receivers from Rohde & Schwarz ESCS30 features not only selftest facilities but also autocalibration routines that ensure adherence to the data-sheet specifications. The current-saving circuit design and the built-in accumulator provide ideal prerequisites for mains-independent, portable use.

Volker Janssen; Matthias Keller

REFERENCES

[1] Müller, K.-O.; Stecher, M.: EMI Test Receiver ESS – The world's first instrument covering 5 Hz to 1 GHz. News from Rohde & Schwarz (1992) No. 138, pp 8–10

[2] Janssen, V.: EMI Test Receiver ESPC – EMC precertification measurements for everyone. News from Rohde & Schwarz (1995) No. 149, pp 16–18

Condensed data of EMI Test Receiver ESCS30

Frequency range	9 kHz to 2750 MHz
Frequency uncertainty	1 x 10^{-6}
Preselection	10 filters
Noise figure	5 dB (<30 MHz), 9 dB (<2750 MHz)
3rd-order intercept point	+20 dBm (<30 MHz), +10 dBm (<2750 MHz)
Bandwidths	200 Hz, 9 kHz, 120 kHz, 1 MHz
Detectors	PK, AV, QP
Types of analysis	RF spectrum analysis, IF spectrum analysis (option), time domain analysis
Tracking generator (option)	9 kHz to 2750 MHz
Interfaces	IEC 625.2 (IEEE 488.2), user port, Centronics

Reader service card 154/02

Series 200 multichannel radio equipment

VHF-UHF ATC radiocommunications go multichannel

Rohde & Schwarz has expanded the existing Series 200 single-channel radio equipment for VHF and UHF communications by adding multichannel equipment. As full-featured system equipment the new generation enables locally or remotely controlled radiocommunications on any channel in these frequency ranges.

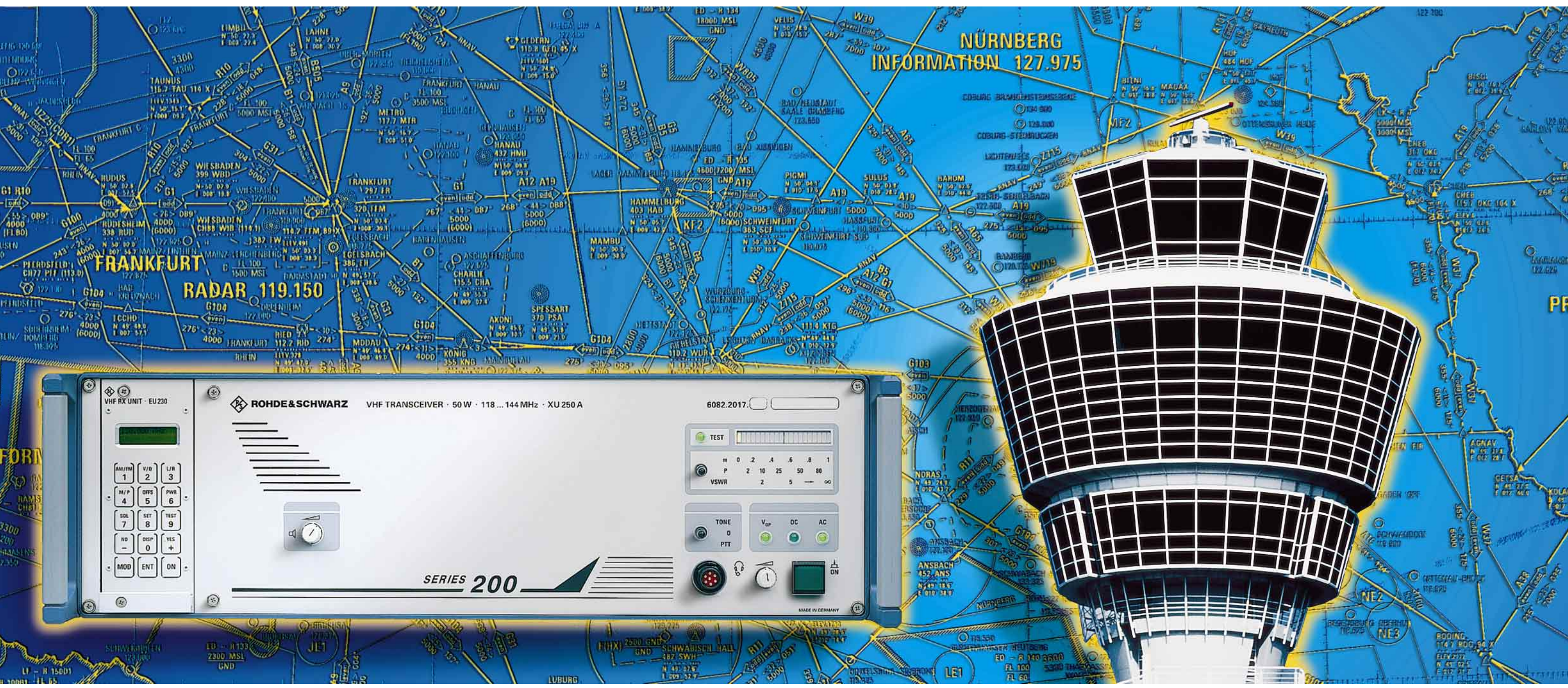


FIG 1 VHF Multichannel Transceiver XU250A serves as standby unit on international airports and as ordinary operational equipment for radiocommunications in small- and medium-sized ATC systems. Photo 42 815

Application

Series 200 multichannel radio equipment is used for instance for **normal standby or emergency standby on international airports.** In normal standby a few multichannel units are used as backups for several single-channel radios, while the emergency standby radio equipment maintains minimum radiocommunications in the event of a total breakdown of a large radio system made up for instance of Series 200 single-channel radios [1; 2]. Such breakdowns can occur if cables (for AF, control, power supply) are damaged by lightning or as a result of careless construction work. In such cases the standby equipment guarantees maximum channel availability and cost efficiency of the entire radiocommunication system.

However, multichannel radios are not only required on international airports but also by **small- and medium-scale operators** who use them as **operational radio equipment** – especially the compact VHF Transceivers XU220A for RF power of 25 W or XU250A for 50 W (FIG 1). Potential users are:

- regional airports for general aviation handling business and private air traffic,
- rescue services with airstrips of their own,
- private shuttle services with their own helicopter landing strips,
- relief services with stationary or mobile radio equipment, for instance in case of humanitarian missions in disaster areas or trouble spots,
- aviation industry with company-owned test airfields,
- explorers of any kind (oil, gas, ores, minerals, wood, etc) with landing strips of their own,
- military services in need of simple and cost-efficient radiocommunications equipment in A3E and fixed-channel mode for ground stations or mobile towers (if the features of the Series 400U multichannel communication system are not required for operational reasons).

Features

The following facilities are common to the **single- and multichannel radio equipment of Series 200:**

- VHF and UHF receiving systems (with up to eight receivers per 19-inch adapter),
- VHF transmitters and transceivers for 25 and 50 W,
- UHF transmitters and transceivers for 30 W,
- PC-controlled Remote Control and Monitoring System RCMS.

The multichannel systems feature the same proven characteristics as the single-channel equipment such as outstanding price/performance ratio, excellent performance data, high availability, advantageous logistics and service concept (flexible modularity, integrated interfaces, test instruments and software, special service kits). The two product lines have the same basic specifications and design. A receiving system can be made up of single- as well as multichannel equipment and connected to the associated multicoupler and test generator. The radios are based on the same modules and subassemblies and operate with the same new RCMS software.

Modifications to the single-channel product line have only been made wherever necessary. To name a few **attractive innovations:**

- digital receiving concept: the use of digital processors allows relatively simple and firmware-controlled adaptation to particular specifications, data optimization and improved test facilities,
- channel spacing (IF bandwidth) in the VHF range selectable between 25 and 8.33 kHz,
- every frequency and preselected channel can be locally and remotely controlled,
- control interface for external antenna filters integrated into transmitters and transceivers, which makes the units fully system-compatible,
- power supply integrated into transmitters and transceivers as standard, which yields cost-efficient logistics,
- new model (.03) of REM Bus Drive Unit GV201 permitting even remote control and monitoring of detached radio stations (RCMS) without separate slave PCs,
- built-in RCMS for single- and multichannel equipment: its high flexibility allows various interfaces to be used and meets practically all operational requirements (FIG 2).

Thanks to these features and the resulting attractive and future-proof applications, Series 200 multichannel radio equipment will no doubt prove to be as successful on the international market as its single-channel counterparts.

Hans-Günther Klarl

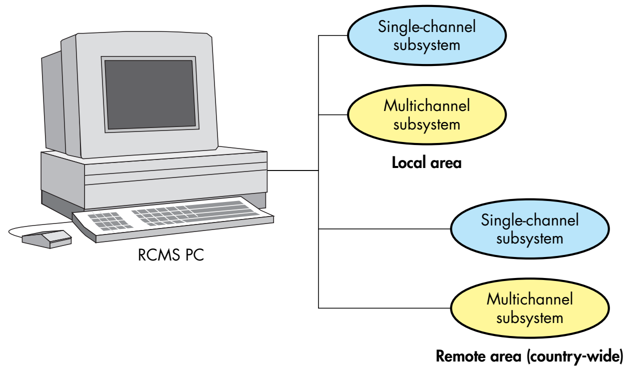


FIG 2 Remote Control and Monitoring System RCMS of Series 200 radio equipment is suitable for practically every type of complex ATC radiocommunications system.

REFERENCES

[1] Klarl, H.-G.: Series 200 VHF single-channel radio equipment – The new dimension in ATC communication. News from Rohde & Schwarz (1993) No. 140, pp 4–7

[2] Klarl, H.-G.; Kessler, M.: Series 200 and 400U radio equipment – Innovations in ATC radiocommunications: RCMS and 8.33-kHz channel spacing. News from Rohde & Schwarz (1996) No. 152, pp 14–16

Condensed data of Series 200 multichannel radio equipment

Frequency range	VHF 118 to 144 MHz
	UHF 225 to 400 MHz
Channel spacing	25 and 8.33 kHz, switch-selectable
Preselectable channels	100
Frequency error	$\leq 1 \times 10^{-6}$ (0 to 40°C)
RF power	VHF 50 or 25 W UHF 30 W
Offset mode	up to 4-carrier offset
Types of equipment	receiving systems, transmitters and transceivers, auxiliary equipment
Remote control and monitoring	integrated for single- and multichannel operation by means of Software GC201-S (.03)

Reader service card 154/03

HF Broadband System XB2900

Custom-tailored shortwave communications

Components for combining several 1-kW or 500-W transmitters/receivers extend the successful HF Transceiver Family XK2000 to HF Broadband System XB2900. Simultaneous transmitter operation on a broadband antenna on different channels and output power increases are now possible. Since the RF power components are passive and broadband, frequency-agile and reliable data and speech links can be set up according to customer requirements with the tried and tested options of the XK2000 family.

Increasing communication traffic and expansive networking call for transmitters to set up links on more than one channel. Mostly, simultaneous use of many radio networks on different transmit frequencies is required. The classic solution to this task is a transmitting antenna with the corresponding transmitter for each radio network. If no broadband antenna is used, a transmitter-specific antenna tuning unit is required where several RF power relays have to be switched whenever the frequency is changed. To keep cross-coupling between the transmitters low, a minimum distance between the antennas has to be maintained, which means large space requirements. Problematical with this approach is that – during the planning phase of such a system – there is relatively high uncertainty as far as the number of simultaneously operated radio networks is concerned and that any redundant transmitters cannot be used for increasing power in critical situations. HF Broadband System XB2900 from Rohde & Schwarz is the right solution here, since it offers simultaneous operation on a maximum of 32 channels into up to three broadband HF antennas.

FIG 1 HF Broadband System XB2900 with 16 1-kW transceivers Photo 42 580/2

Configuration of HF broadband system

HF Broadband System XB2900 comprises RF components of the XK2000 family, a power management unit as well as a supervisory control system for convenient operation.

RF components

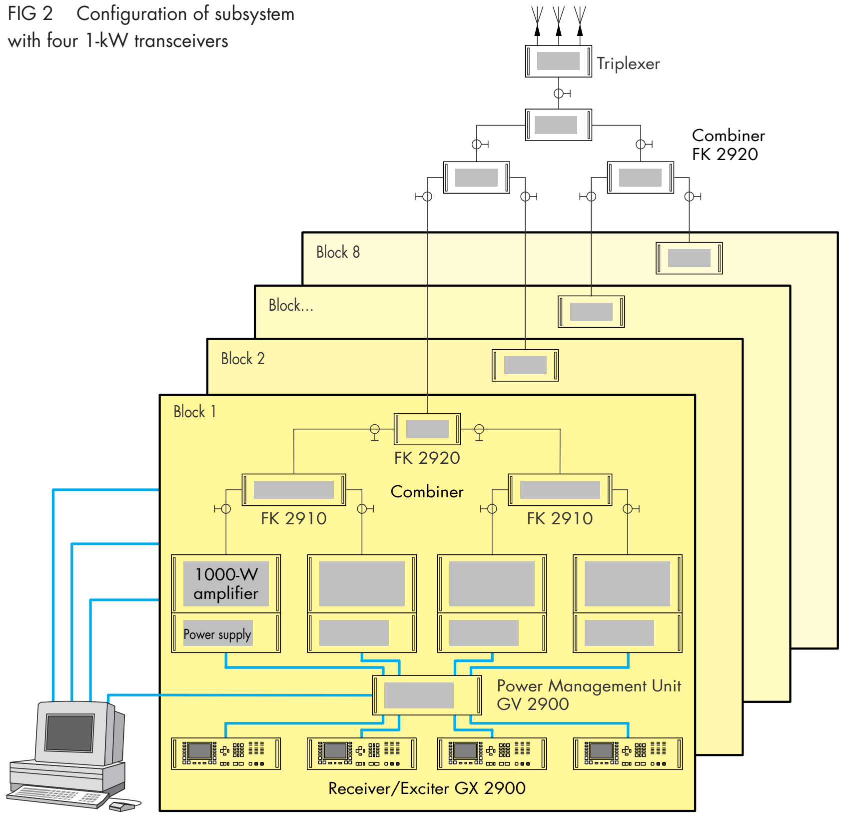
Digital 1-kW HF Transceiver XK2900 consisting of receiver/exciter, 1-kW power amplifier as well as power supply [1] forms the core of the HF broadband system. These standard components are also ideal for use in classic applications with narrowband transmitting antennas. As **Receiver/Exciter GX2900** has digital signal processing at the IF, a number of interesting features are offered such as eleven receive bandwidths as well as the digital voice compressor to name a few examples. Operation is possible via softkeys but also via the serial interface. The basic modules and options introduced for 150-W Transceiver XK2100 [2] and 500-W/1-kW Transceivers XK2500/2900 [1] can also be used for HF Broadband System XB2900.

The MOSFETs in **1000-W Power Amplifier VK2900** provide sufficient power reserves. The amplifier control with its numerous protective circuits ensures high reliability of the amplifier even under extreme operating conditions.

The receiver/exciter and the power amplifier are powered by **Power Supply IN2900.**

Combiners FK2910 serve for combining the RF outputs of two power amplifiers. If two of these combiners are to be connected, a Combiner **FK2920** with a higher power rating is used. If signals of equal phase are applied to the combiner inputs, roughly twice the

FIG 2 Configuration of subsystem with four 1-kW transceivers



case the power management unit is configured once with a standard PC. Hardware configurations are not required.

Application

FIG 1 shows an HF broadband system with 16 HF Transceivers XK2900. In its maximum configuration the system consists of 32 HF transceivers. The outputs of two power amplifiers are combined by broadband combiners. The output signals of these combiners are taken to a broadband transmitting antenna via several Combiners FK2920 or to three transmitting antennas via Triplexer FK2950. The reduction in the number of transmitting antennas thus achieved is especially interesting for use onboard ships. Its high flexibility makes the system also ideal for land-mobile applications. Each transceiver/exciter can be used as a complete receiver – eg for full-duplex mode – provided that no power amplifier is assigned to it.

The whole HF broadband system can be divided into **scaleable subsystems** each comprising a Power Management Unit GV2900 per block (FIG 2). Up to four receivers/exciters and four power amplifiers can be connected to each power management unit. Since it is not necessary to fully equip the power management unit with receivers/exciters and power amplifiers, high flexibility is offered to meet customer requirements. If not all the components are available, transmission will be maintained with the remaining power amplifiers. The logic connection between the receivers/exciters and the allocated power amplifiers is made from the power management unit through commands. The allocations can be modified within seconds without the use of any RF power relays, which are subject to wear and tear. Command and monitoring operations are performed by the supervisory control system via a serial interface per power management unit.

power is available at the output. High decoupling at the combiner inputs allows different signals to be emitted at the same time but the output power is cut by half. The remaining power is taken to external absorbing resistors to prevent the power amplifiers warming up unduly.

Triplexer FK2950 combines three transmitting antennas such that low-loss radiation between 2 and 30 MHz is obtained. Antenna switches are not required.

Power management unit

Power Management Unit GV2900 plays a major role in the HF broadband system since it processes all the information of the connected RF and control components. It also evaluates the control telegrams of the receivers/exciters and passes them on to the allocated power amplifiers. At low signal levels, the RF signals of the receivers/exciters are distributed to one, two or four power amplifiers. Moreover, two power management units can be cascaded so that up to eight 1-kW power amplifiers can be controlled via an exciter. The control telegrams are evaluated in realtime in a field-programmable gate array.

All the components of the HF broadband system are continuously monitored and support a built-in test. The power management unit plays a central role: it directs the monitoring of the RF components and responds to error messages. Simple error analysis encompasses a loop test of all the control interfaces and monitoring of the levels of the RF interfaces by means of an internal test generator.

Control system

The HF broadband system is controlled by a controller with a graphical user interface. Additional HF, VHF and UHF transceivers can also be controlled via this user interface. The phone extensions to wired and wireless communication can be allocated via an integrated intercom system. The system can also be operated without a controller. In this

With a power management unit equipped with a single receiver/exciter and four power amplifiers, the system described can also be operated as an **HF transceiver with increased output power.** As far as control is concerned, this system behaves like a 1-kW Transceiver XK2900.

Holger Buchholz; Hendrik Köhler

REFERENCES

[1] Träger, R.: HF Transceivers XK2500 and XK2900 – The new members of HF Transceiver Family XK2000. News from Rohde & Schwarz (1997) No. 153, pp 12–13

[2] Helmke, B.; Wachter, G.: HF Transceiver XK2100 – Digital shortwave for future-proof, long-haul communication. News from Rohde & Schwarz (1994) No. 144, pp 4–7

Condensed data of HF Broadband System XB2900 with four transceivers

Frequency range	
Transmission	2 to 30 MHz
Reception	10 kHz to 30 MHz
Output power into 50 Ω	1 x 3 kW/2 x 750 W/4 x 190 W (±0.5 dB each)
SWR at output	<3
Frequency spacing of transmitting amplifiers	>1%
Time for frequency change	<25 ms
Switchover time T/R	<10 ms
Time for change of combining mode	<3 s (typical)
Operating temperature range	–25 to +55°C
Remote-control interfaces	RS-422/RS-485 or RS-232

Reader service card 154/04

Feedback

A letter from Switzerland

Engineer E. Meyer-Hofer, formerly owner of a radio and TV sales and service center in Rothrist in Switzerland, writes the following:

"The great admirer of Rohde & Schwarz that I am, I first came into contact with Rohde & Schwarz T&M equipment as a young engineer in the early 40s. I have ever since been fascinated by how high the scientific standard of this equipment was even then, so in my professional life R&S came to be the make of my choice whenever I had to buy test equipment and had the money. I am enclosing a photo of several nostalgic R&S measuring instruments, which I kept after my retirement and which I would not want to give away, because they still work with all their functionalities."

We would like to thank Mr. Meyer-Hofer very much for his letter and wish him many more years of enjoyment with his Rohde & Schwarz equipment.

QAM Transmitter CT100QT

Processing digital TV signals for cable headends

A small cost-effective module is all that is needed to add digital programs to analog TV programs in cable headends. QAM Transmitter CT100QT, which is fully compatible with the successful CATV Headend System CT200 from Rohde & Schwarz, processes digital vision and sound signals for feeding into the broadband cable together with analog signals.

Uses

Broadcast cable networks are increasingly expanding to digital programs, not only in the cable headends of Deutsche Telekom but also in those of private national and international operators. QAM Transmitter CT100QT (FIG 1) from Rohde & Schwarz was developed for feeding digital TV programs from fiber-optic cables or satellites into the broadband cable network. Notable features of this transmitter are its compact design, system compatibility, remote-control capability and an attractive price, which also makes it a candidate for smaller systems. CT100QT comprises a QAM modulator and an upconverter so that digital TV program data available at its output are ready to be fed into the broadband cable. For special applications, the modulator and upconverter can also be supplied as separate modules, ie Modulator CT100QM and Upconverter CT100UP. The CT100 components are fully compatible with CATV Headend System CT200 [1] and thus ideal for supplementing existing analog cable headends from Rohde & Schwarz with digital programs. The benefits of CT200 such as active standby, remote control via PC and modem or self-monitoring are also offered by CT100 modules. Moreover, an additional RS-232-C interface is integrated for firmware updates.

Operation

The operation of QAM Transmitter CT100QT is fully digital up to the IF, which can be selected in 1-MHz steps between 31 and 41 MHz, and thus provides quadrature amplitude modulation in excellent quality. Blocks of 188 or 204 bytes can optionally be used for input data. At a frame length of 204 bytes the last 16 bytes are assigned for error control. All QAM modes can be set, ie 16, 32, 64, 128 and 256QAM with DVB-compliant mapping [2]. The signal is shaped by means of a root-cosine roll-off in line with DVB. Any other spectral shaping is possible by loading the shaping filter via the PC interface. The output data rate can be selected freely between 500 kbit/s and 55.2 Mbit/s independently of the input data rate. The only requirement to be met is that the applied net input data rate should be less than the set output rate. The two data rates are matched by removing or adding so-called stuffing blocks. The jitter thus caused in the time stamps is kept below the range stipulated in the ETSI standard by correction of the PCR (program clock reference) values. The asynchronous serial interface (ASI) and the synchronous parallel interface (SPI) are implemented as data inputs (FIG 2). The converter transforms the spectrum generated at the IF to the RF in inverted form. The user can define whether mapping is to comply with the specs at the IF or RF. The frequency is selected via the passive channel filter, which is plugged externally to the module to make for easy exchange. Frequency resolution of 10 kHz allows almost any channel spacing to be chosen.

Data processing and channel coding

Incoming data (MPEG2 transport stream) are converted into a parallel TTL signal with a clock signal and are written into an FIFO memory without storing the stuffing blocks. The fill state

FIG 1 Highly cost-effective and modular QAM Transmitter CT100QT adds digital to analog programs in cable headends. Photo 42 823

of the FIFO is monitored and, if sufficient data are available in the FIFO, a whole block is read out. Otherwise, a stuffing block is inserted into the data stream. The stuffing block consists of the sync word and PID (program identification). A continuous PRBS (pseudo-random bit sequence) is sent in the data section of the stuffing block, ie the PRBS generator is stopped during the header. The data rate defined by

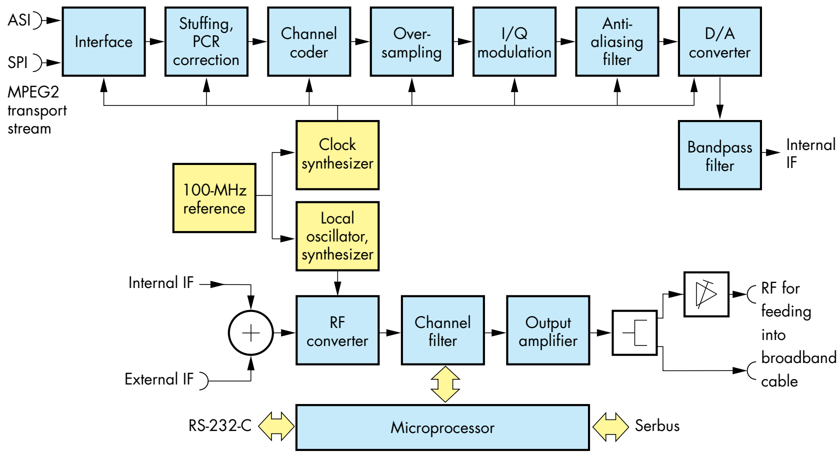


FIG 2 Block diagram of QAM Transmitter CT100QT

the user will thus be used. The time delay of the PCR values is corrected by recalculating the time stamps. If no data are present at the selected interface, a continuous PRBS signal is sent that is interrupted by the sync byte only. The PRBS signal is not affected by energy dispersal, error control and interleaving. In addition to this automatic switchover, transmission can be fixed to PRBS or data.

A channel coder then scrambles the processed data to avoid long sequences of 0s or 1s. After every eighth block the scrambler is reinitialized and the sync byte inverted to mark this event. In the following block, 16 bytes are calculated for Reed-Solomon error control and added to the data of a block. The subsequent interleaver distributes the bytes of a block among twelve blocks so that block errors occurring in the channel can be corrected.

Mapping and spectral shaping

Data are next combined to new symbols according to the QAM mode: for 64QAM symbols with 6 bits per symbol are generated. The two upper bits are phase-differentially coded and form a set of I and Q values for each of the 64 symbols using a mapping table. The two I and Q signals are subjected to fourfold oversampling and then spectrally shaped in the interpolation filter (in line with root-cosine standard).

To ensure that the D/A converter always receives roughly the same data rate, irrespective of the symbol rate generated by the data section, the signal is again oversampled at a variable rate. The digital mixer amplitude-modulates two orthogonal IF carriers with the digital signals and finally adds them to a carrier modulated in amplitude and phase. The two carriers are generated by direct digital synthesis, which ensures an accurate phase relation between them. I/Q imbalance, ie difference in I and Q signal amplitudes, is excluded due to the digital processing of the baseband (I and Q) signals. Since the amplitude modulation of the two carriers is performed through multiplication of two digital values, highly effective carrier suppression is achieved.

D/A conversion and analog filtering

An FIR (finite impulse response) filter processes the digital IF signal and compensates for the sine(x)/x roll-off generated in the D/A converter. The IF level can be varied in a range of approx. 6 dB by means of the D/A converter. The subsequent analog bandpass filters the desired spectrum from the periodically recurring spectra. The signal can be reduced by 6 dB with a switchable attenuator. An external IF input allows a frequency multiplex to be generated at the IF. The external IF signal is added to the internal signal non-reactively in an active adder stage and then taken to the converter.

Conversion to RF channel

After measuring the level of the IF sum signal and setting the IF level, the QAM signal is converted to the RF channel by inversion. Unwanted mixture products are filtered out by a passive filter plugged externally to the module. If the frequency is to be changed, the filter simply has to be exchanged. The channel filter itself defines the synthesizer setting of the local oscillator. A signal for controlling the IF setting element is calculated based on a comparison of RF and IF level, thus keeping the output level constant in all frequency ranges. The RF output signal is provided at two outputs with different levels from one another.

Clock-signal generation

All signals used in the module (except for the input data clock) are derived from a highly stable 10-MHz crystal oscillator. All output signals thus have the same stability as the reference. For digital processing a clock signal with 2^n times the symbol frequency is generated by a synthesizer (n depends on the selected output data rate) and all other clock signals are derived through division. The signal for converting the IF signal into the RF channel is provided by a synthesizer with the 10-MHz signal as a reference. The whole frequency range is covered by two oscillators by switching between them and variably dividing their frequency.

Control and self-monitoring

All functions of CT100QT such as IF, symbol rate, QAM mode and output level can be remotely controlled via a serial interface. A large number of parameters are also continuously monitored and an error message is issued if the tolerance is exceeded. The clock frequencies of the digital section too are measured and the output signal is switched off on the occurrence of an error. Adjacent channels will therefore not be disturbed by too wide a QAM spectrum. The signal is also switched off and an error message issued if the signal at the RF output is too high.

Walter Bschor

REFERENCES

[1] Schönberger, P.; Sturm, P.; Scheide, R.: CATV Headend System CT200 – CATV signal processing intelligent, compact, versatile. News from Rohde & Schwarz (1995) No. 148, pp 23–25

[2] European Telecommunications Standards Institute ETSI: Digital broadcasting systems for television, sound and data services; framing structure, channel coding and modulation cable systems. Draft prETS 300 429 (1994)

Condensed data of QAM Transmitter CT100QT

Modulation	16, 32, 64, 128 and 256QAM
Inputs	ASI (75 Ω)/SPI, LVDS (100 Ω)
Output data rate	500 kbit/s to 55.2 Mbit/s
Transmit frequency range	108 to 862 MHz
RF output level 1/2	72 to 87 dBpW/83 to 95 dBpW
Bit error rate	$<1 \cdot 10^{-9}$ (with corresponding demodulator)

Reader service card 154/05

Reference

One wavelength ahead

This is the motto under which the south German company of Mikes Product Service GmbH, a subsidiary of TÜV Product Service GmbH, offers its services to customers all over the world. Mikes Product Service is a leading, independent, accredited test lab for approval measurements and product certifications in line with national, European and international guidelines in the fields of EMC, telecommunications and security. On open-area test sites, in shielded cabins and anechoic chambers equipped with state-of-the-art test instruments, Mikes Product Service performs EMC measurements on medical systems, industrial machines, µP controls, laboratory instruments, vehicles, vehicle components, for instance. Testing terminal equipment such as CB radios, car immobilizers, cordless telephones and telemetry systems also belongs to the wide range of services offered by the test specialist. The TÜV Product Service group with more than 40 branch offices and laboratories in Europe, the US and Asia and over 250 EMC and telecommunications experts is the largest independent EMC competence center worldwide.

To be able to adhere to the corporate principle "Short turnaround time, high competence, quality and flexibility" Mikes Product Service has equipped its test labs with the latest EMC test instruments and systems from the comprehensive Rohde & Schwarz product range.

The Mikes brochures below illustrate the spectrum of measurements performed by this company. Sö

Paging Transmitters SU330/SD330

New transmitters for nationwide coverage

Ultra-high availability at low cost of ownership is ensured by VHF and UHF Paging Transmitters SU330 and SD330 for nationwide paging networks according to ERMES, POCSAG, FLEX and APOC standards. No matter whether for new installation, retrofitting or upgrading – Paging Transmitters SU330/SD330 can be installed in an extremely short time and adapted to the specific task simply by software.

FIG 1 VHF Paging Transmitter SU330 for output power of 200 W Photo 42 622

The results obtained from the planning of modern nationwide paging networks show that countries with a size and infrastructure like Germany require more than 1000 transmitter sites for full coverage. Depending on the paging standard and frequency range as well as the type and number of paging calls to be transmitted, these paging base stations can be equipped with one or more transmitters*. The advanced concept of Paging Transmitters SD330 and SU330 (FIG 1) covering different paging standards, frequency ranges, power classes and hardware configurations enables fast installation, retrofitting or upgrading of radiopaging networks at a minimum of investment costs.

In addition to basic features such as availability in all international frequency ranges and suitability for all modern paging methods, Transmitter Family SU330/SD330 has especially been designed to **minimize cost of ownership:**

- optimized coverage with output power between 20 and 400 W and maximum modulation accuracy at the same time,
- different protocols and baud rates supported exclusively by software,
- uniform, intelligent and comprehensive concept for operation, administration and maintenance,
- multilevel maintenance strategy with on-site service of paging transmitters by local electricians,
- easy integration into existing communication networks as well as into cost-optimized and unobtrusive outdoor cabinets.

Technical design – modular and flexible

Paging Transmitter SU330 generates a spectrally pure VHF signal modulated to the paging standard (FIG 2), whereas SD330 generates the corresponding UHF signal. Via a directional coupler output the forward and reflected power at the transmitter output can be determined; a monitor output allows a spectrum analyzer or similar test equipment to be connected. An I20+ interface compatible with the de-facto standard I20 supplies the transmitter control unit with all the configuration information and modulation data required for controlling the modules. House alarms can be connected at the input/output interface (option) and transmitted via the I20+ interface. The outputs of this option can be used to switch external equipment. A commercial PC can be connected to the front panel of SU330 for diagnostics and configuration tasks. The high stability of the transmit frequency necessary for single-frequency network operation (simulcast) is guaranteed by an external reference frequency, which is usually supplied by the controller in each paging base station. An oven-controlled reference oscillator can be integrated as an option.

Using the same hardware, Transmitters SU330/SD330 digitally generate all types of modulation required for the relevant paging standards. This enables network operators to change to a different paging standard by firmware download and remote control of the transmitter parameters – "on the fly" – without having to manipulate the existing network infrastructure. Channel spacing and frequency deviation can of course be adapted to national requirements. The table in the blue box lists the technical parameters of the modulation types and paging standards supported by SU330/SD330.

* Rieder, T.: Paging System P2000 – Flexible, multiprotocol radiopaging system. News from Rohde & Schwarz (1996) No. 151, pp 25–27

Modulation	Paging standard	Transmission data rate in kbit/s	Channel data rate in kbit/s
FSK	POCSAG	0.512/1.2/2.4	0.512/1.2/2.4
	APOC	1.2/2.4/3.2	1.2/2.4/3.2
	FLEX	1.6/3.2	1.6/3.2
4FSK	ERMES	6.25	3.125
	APOC	4.8/6.4	2.4/3.2
	FLEX	3.2/6.4	1.6/3.2

Ultra-high reliability and cost effectiveness

One of the most important parameters for network operators is the **reliability of the infrastructure used.** If redundancy becomes necessary because of poor MTBF (mean time between failures) of the infrastructure components, the investment costs will increase disproportionately to the achieved improvement in reliability. Thanks to the very low temperature of the power stages and good heat dissipation of the isolators and filters, Transmitters SU330/SD330 guarantee extremely high MTBF. Even at ambient temperatures of 50°C the maximum heatsink temperature is just 20°C higher, which means an MTBF of over 28,000 hours.

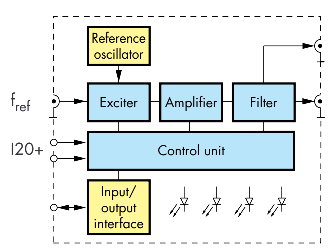


FIG 2 Block diagram of Paging Transmitter SU330 (options yellow)

The **OAM functions** (operation, administration and maintenance) of a mobile-radio network are closely related to the service concept for the infrastructure. The transmitters in the base stations are of particular importance in this context since they are components that may exist many times within the system. The **operating costs** are mainly determined by the following **factors:**

- frequency and duration of regularly performed service work,
- frequency and duration of on-site servicing due to faults,
- qualification of service personnel,
- equipment required for on-site servicing.

Paging Transmitters SU330/SD330 come very close to the ideal of a completely maintenance-free infrastructure. The components themselves and on-site installation are of extreme **service-friendliness:**

- A continuous built-in test monitors all relevant parameters and signals every limit violation.
- The OAM system allows defects to be identified down to module level before the service personnel sets out to the site.
- Defective modules can immediately be identified on-site thanks to front-panel LEDs, which does away with the need for specialized knowledge.
- The modules are easily accessible and there is no risk of interchanging or incorrectly connecting them in the event of a replacement.
- The only regular service necessary is to check the long-life fans every two years.

Network operators are thus in a position to introduce a cost-optimized, three-stage service concept: When defects are clearly identified (red LEDs), the module concerned is replaced by a qualified local electrician. In case of more complex faults the defective modules are localized at the site by a specially trained service technician using a PC and optical indications for troubleshooting, and then the modules are replaced. Servicing down to component level is performed either by Rohde & Schwarz or by the network operators' service centers.

Local status indication

LEDs give a fast overview of the status of an active paging transmitter without any tools or manual operation being necessary. The LEDs inform about the following parameters: power supply, status of interfaces and built-in test of individual modules. The well-known colours of the traffic lights are used for signalling: red means "Stop" indicating module or part no longer operational, yellow is for signalling of operational parameters, and green is for "Go" – showing status OK, configuration successful. A PC can be used for acquiring and monitoring further status messages and measured values of the transmitters. The result log in the transmitter stores the parameters of ongoing operation in line with the required configuration and serves for instance as a basis for the statistical evaluation of site-related operational data.

Thomas Rieder; Michael Müller

Condensed data of Paging Transmitters SU330/SD330

Frequency range SU330/SD330	146 to 175 MHz/440 to 475 MHz
Output power SU330/SD330	<400 W/<100 W
Paging standards	ERMES, POCSAG, FLEX™, APOC™ incl. combined on-the-fly mode
OAM concept	widely expanded functions as compared to I20 de-facto standard, I20+ for remote control, RS-232-C for local PC control
MTBF	>200,000 h (25°C)/>28,000 h (50°C)

Reader service card 154/06

Satellite Tracking Antenna AS809

Radiomonitoring LEO communication satellites

Rohde & Schwarz has developed a broadband microwave antenna to be used for varied monitoring tasks in future satellite communications. This antenna can receive signals emitted by fast-moving LEO (low earth orbiting) satellites in addition to signals from geostationary satellites.

FIG 1
Satellite Tracking Antenna AS809 for 1 to 18 GHz
Photo 41 722/9

The end of this millennium is seeing the rise of a new form of global communication, which makes use of satellites. This form of communication involves portable terminals that allow blanket worldwide coverage and thus supplements local terrestrial networks such as GSM. When planning this type of communication, various satellite configurations were considered. Initially considerations focused on the frequently used geostationary satellites, ie satellites orbiting at the rotational speed of the earth. When viewed from the earth, these GEO (geostationary earth orbiting) satellites appear to be stationary in the sky. However, this state of equilibrium is only possible at a distance of around 36,000 km from the earth, so the terminals used must have directional antennas, and a transmission power of around 25 W. A very compact terminal of this type is Satphone SP1600 from Rohde & Schwarz [1], which is the size of an attaché case. The use of terminals the size of mobile phones is only feasible with satellites orbiting the earth at a distance well below 36,000 km. Successful communication systems so far have used MEO (medium earth orbiting) satellites flying at medium altitudes (approx. 10,000 km) and LEO satellites orbiting at low altitudes (approx. 1000 km).

Space radio service monitoring

For space radio service monitoring [2] these latest developments bring about the need for satellite receive antennas capable of tracking satellites at low altitudes. The **most important tasks in monitoring LEO satellites** are:

- monitoring the radio frequency spectrum in order to detect and identify satellite emissions,
- allocating frequency bands and supervising their use,
- determining satellite position and orbit stability,
- measuring and documenting the characteristics of satellite emissions,
- examining radio interference caused by satellites,
- examining radio interference caused by ground facilities,
- detecting unauthorized transponder use.

Rohde & Schwarz has been offering favourably priced antenna and receiving systems [3] for this range of tasks for some time. Non-geostationary satellites, on the other hand, must be continuously tracked while measurements are being performed. In addition, unknown satellites have to be tracked down and their orbits determined. Rohde & Schwarz has now developed and successfully put into operation a receiving system that meets these requirements.

Monitoring system with Antenna AS809

At the heart of the monitoring system for LEO satellites is Antenna AS809, which allows polarization-independent tracking according to the monopulse principle – ie independent of the type of signal being dealt with (FIG 1). The antenna reflector and the positioning system were developed in cooperation with Vertex, the former Krupp Industrietechnik. Reflectors may be 8 to 11 m in diameter.

The frequency range is 1 to 18 GHz, but thanks to the high-precision reflector it may also be extended to cover the VHF and mm ranges. The antenna is part of the fully processor-controlled Radiomonitoring System RAMON [4], whose receiving components allow a

FIG 2 Receive components of Radiomonitoring System RAMON serve for processing data provided by Antenna AS809. Photo 41 515/4

REFERENCES

[1] Böhler, U.: Shortwave radio or satellite communication? News from Rohde & Schwarz (1995) No. 149, pp 57–59

[2] ITU Spectrum Monitoring Handbook 1995, chapter 4.1

[3] Schiller, M.; Sigl, G.: Antenna AC002B5 and Receiving System EA002B5 – Processor-supported monitoring system for 0.1 to 18 GHz. News from Rohde & Schwarz (1995) No. 147, pp 7–9

[4] Ehrichs, R.; Holland, C.; Klenner, G.: Radiomonitoring System RAMON – Customized radiomonitoring from VLF through SHF. News from Rohde & Schwarz (1996) No. 151, pp 19–21

no-gap conversion of a wide frequency band to the intermediate frequency range 70 MHz (FIG 2).

A glance at the specifications of Satellite Tracking Antenna AS809 will reveal that the antenna has plenty of reserve for future LEO communication systems.

Dr. Klaus Rieskamp

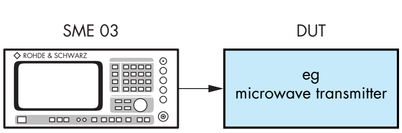
Condensed data of Satellite Tracking Antenna AS809

Diameter	≤11 m
Frequency range	1 to 18 GHz
Bandwidth	50 kHz to 40 MHz
Polarization	V/H linear, RHCP/LHCP
Signal channel	independent of tracking
Side-lobe suppression	using extra antenna
Tracking	3-channel Σ/Δ monopulse
Search	antenna for sector and spiral search
Angular speed	<15°/s (azimuth) / <7.5°/s (elevation)
Angular acceleration	$<7°/s^2$
Power consumption	approx. 60 kVA

Reader service card 154/07

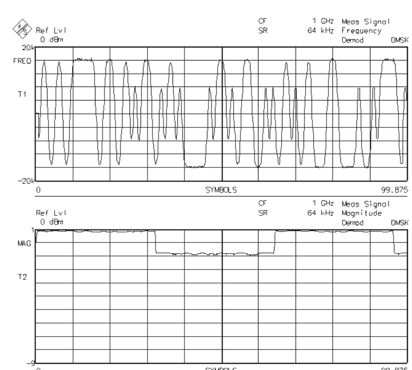
Test signals with analog and digital modulation for vehicle information systems

With more and more cars on the road, intelligent traffic control and management systems are gaining in importance in keeping the traffic flow going, especially in cities and on highways. The first, large-area system for complete traffic management was introduced in Tokyo and its surrounding areas in 1996 under the name VICS (vehicle information and communication system). VICS collects traffic information (for instance about traffic jams, road blocks or car park occupancy) in an area of about 500 km^2, processes these data in a control center and passes the information on to the car drivers via microwave transmitters, infrared transmitters and VHF FM sound broadcasting. In the cars, the data are processed by a navigation system and indicated on a display.



Signal Generator SME03 with its versatile digital and analog modulation characteristics is an ideal source for the development and production of VICS components – in particular microwave transmitters and receivers. The microwave transmitters operate at a frequency of about 2.5 GHz. The data supplied by VICS are GMSK-modulated onto the carrier with a data rate of 64 kbit/s. This digital modulation is superimposed by analog amplitude modulation (modulation index 10%, modulation frequency 1 kHz), which is analyzed for position determination. The test signal on the right shows the frequency deviation and the amplitude of the modulated carrier signal versus time as furnished by SME03. SME03 fully satisfies the exacting requirements of VICS regarding modulation quality and synchronization of analog and digital modulation.

Mathias Leutiger



Reader service card 154/08

CMD80: measurements for CDMA and AMPS mobiles

FIG 1 Digital Radiocommunication Tester CMD80 – specialist for CDMA (code-division multiple access) and AMPS (advanced mobile phone service)
Photo 42 816/1

Rohde & Schwarz, a world market leader in mobile-radio measurements, and its US partner company Tektronix have jointly developed a mobile-phone tester for the US mobile-radio system CDMA to IS95 standard: Digital Radiocommunication Tester CMD80 (FIG 1). It also incorporates the technology needed for measurements in the predecessor analog AMPS network, which is still in use. CMD80 measures the RF and AF parameters of mobile stations supporting both standards or dual-mode equipment in development, production and service with the aid of network-specific signalling. It covers the 800-MHz band (cellular radio mobiles for CDMA and analog AMPS), the 1900-MHz band (PCS mobiles for CDMA, PCS = personal communication system) and the 1700-MHz band for the Korean variant of CDMA.

GSM was the first fully digital mobile-radio network. It has been well established in Europe and is now spreading worldwide. The American response to the successful European standard was CDMA, set down in standard IS95. This mobile-radio system is competing worldwide with GSM. In contrast to mobile-radio network operators, it is not for Rohde & Schwarz to opt in favour of one or the other of these two competing standards. Rohde & Schwarz offers T&M technology for all major digital mobile-radio networks. T&M experience gathered through working with one network may be used beneficially with another. Special features of the individual networks are taken into consideration. The **CDMA system** has a number of such **special features** with implications for the measurements themselves:

- A single subscriber occupies 100% of the radio channel resources (time and bandwidth). Every further subscriber will require the same. This means that each subscriber is a potential source of interference for all the others. For a subscriber at a certain distance from a base station not to be blocked by another subscriber close by, the signals of all mobiles are required to have approximately the same level at the base station. So it is necessary to ensure through measurements that the mobile transmitter has sufficient dynamic range and that it is able to adjust its output power fast and exactly (range of open-loop power control, time response of open-loop power control, FIG 2, range of closed-loop power control). Essential for network operation is the reliable power adjustment of each and every mobile station.

- CDMA signalling is as complex as in any other network. Some aspects are particularly critical, requiring special care on the part of the tester for the system to work smoothly. Before a mobile is linked to the network, it is not subjected to power control from the base station. The mobile therefore has to probe into the network at very low power (random access, access probe output power). Accessing the network with high power could lead to all active subscribers being blocked. This signalling procedure and others of similar complexity are offered by CMD80 to guarantee smooth network operation. The remaining signalling serves for setting the mobile phone into a state in which RF and AF measurements can be carried out.

- Another consequence of the above is that the receiver of a mobile station is confronted with a large number of simultaneous signals. The base station emits not only the signal to be received by the mobile, but at the same time and at the same frequency also the signals for the

CDMA measurements by CMD80 to IS98

Signalling
Broadcast system information
Random access
Registration
Call setup mobile to base
Call setup base to mobile
Power change
Frequency change
Mobile-initiated call release
Base-initiated call release

Receiver test
Receiver sensitivity and dynamic range

Transmitter test
Frequency accuracy
Waveform quality
Range of open-loop output power
Time response of open-loop power control
Access probe output power
Range of closed-loop power control
Maximum RF output power
Minimum controlled output power
Standby output power and gated output power

remaining mobiles plus a synchronization aid for all mobiles. On top of all that, interference from other cells is also present. For this reason, numerous variants of receiver testing have been worked out. Besides the useful signal, CMD80 simultaneously provides a large variety of useful and interfering signals for receiver testing.

- With all subscribers communicating on the same frequency, anyone can disturb anyone. The positive side of the coin is that while an active subscriber is not speaking and therefore not transmitting (which, according to statistics, is the case in more than 50% of the time on average for bidirectional speech), his mobile does not produce any interference, thereby releasing system capacity for additional subscribers without any organizational efforts. The variable rate speech coder, which reduces transmission activity in three steps for reduced speech activity, produces some special characteristics relevant for measurements which have no equivalent in GSM networks. Transmission activity is reduced by transmitting only at irregular intervals, but with nominal power during those periods. There is a special power ramping measurement function dedicated to this characteristic (gated output power).

Bearing these facts in mind, Rohde & Schwarz made a careful selection of measurements to be performed by Digital Radiocommunication Tester CMD80. A considerable number of the measurements and signalling operations implemented in CMD80 are similar to those in other networks. These are supplemented by CDMA-specific features (compiled in blue box top left).

CMD80 also offers transmitter measurements revealing more than what is stipulated in the standard specifications. Measurements to standard only have to differentiate between good and bad units, while the additional measurements performed by CMD80 also provide detailed information on the possible origins of faults. These measurements include error vector magnitude, phase error and magnitude error (each with peak value, rms value and parameter versus time), carrier feedthrough, IQ imbalance as well as an audio test (acoustic echo) and checking operating voltage and current.

In the US, cellular phones were first operated in the **analog network AMPS.** Succeeding systems with higher spectral efficiency were used in the same 800-MHz band to supplement and provide additional capacity to the AMPS network. Each of these succeeding networks is required to be able to work with the original network in dual mode, and this is likely to remain so in the foreseeable future. Therefore CDMA mobiles must also be able to work with AMPS in the dual mode. Consequently, measurements have to cover both modes as well. This is no problem for CMD80: the blue box below shows an overview of the available AMPS measurements. In addition, a handover function allows linking the two systems CDMA and AMPS.

AMPS measurements by CMD80 to IS55

Signalling
Broadcast system information
Registration
Call setup mobile to base
Call setup base to mobile
Power change
Frequency change
Mobile-initiated call release
Base-initiated call release

Transmitter test
Carrier frequency
Power/standby power/access power
Modulation deviation limiting
Transmitter audio response
Hum and noise
Modulation distortion and noise
Overall peak deviation
Frequency error (supervisory audio tone)
Peak deviation (SAT)
Frequency error (signalling tone)
Peak deviation (ST)
Peak deviation (audio)

Receiver test
Receiver sensitivity (SINAD)
Hum and noise
Harmonic distortion
Receiver audio frequency response

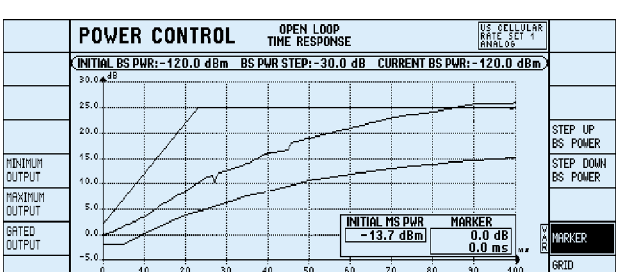


FIG 2
Parameter versus time of mobile station power with tolerance limits

Thomas Maucksch

Reader service card 154/09

Low-cost continuity check in board testing using Cocheck II

Continuity check module Cocheck II for use with TSA [1–3] and TSU [4] tester families allows most soldering defects and insertion faults of ICs to be detected without expensive digital test configuration.

It is hardly necessary to emphasize the benefits of classic analog-digital in-circuit testing (ICT) for the detection of typical production faults. Especially the typical SMD boards fitted with high-pincount, complex ICs call for three requirements which have their price:

1. high digital pincount of the tester,
2. library elements for various types of ICs,
3. accessibility of all nodes.

Basically, a digital tester configuration is much more expensive than a purely analog one. Another point is that due to high-pincount ICs a large number of digital channels must be available simultaneously, so that in systems with multiplex operation more pins have to be provided than actually needed. Automatic program generation is simple for instance if a test model is available, as is the case for all standard ICs in the library. For customer-specific and programmable ICs, this may involve considerable extra time and money to cover each individual program. If some nodes become inaccessible, it is not just the test of the inaccessible pins but the test of the whole IC that cannot be carried out.

These restrictions can be evaded by using Cocheck II as a supplementary test method to the analog ICT, however at the cost of a somewhat lower fault detection rate than with digital ICT.

Test method

Cocheck II verifies the existence of a conductive connection between an IC pin and the board with the aid of a magnetic field generated by a small current injected in the IC pin (FIG 1). Two magnetoresistive sensors above the IC detect the field components in X and Y direction. By analyzing the total magnetic field vector in amplitude and direction, the characteristic of the IC connection on the board can be determined and interference caused by current in adjacent tracks or by mechanical spread can be considerably reduced. Such small injected currents practically always flow via parasitic components in the IC, eg protective diodes, to the supply pins or other IC pins. The current does not depend on the function of the IC but solely on the input-output assignment and the technology, which makes program generation much easier.

The test principle employed in an in-circuit test system is shown in FIG 2. The current injected into a node via the bed of nails may be distributed to several ICs. Since a separate sensor is allocated to each IC, the current flowing through a specific pin is detected, so that a fault can unambiguously be assigned to the IC pin rather than just to the node. Sensor 1 can detect a current flow, whereas sensor 2 does not see the current injected into IC 2, which has an unsoldered pin and is at the same bus node. The switching matrix allows stimulation at each node, the sensor multiplexer selects a specific sensor and routes the boosted signals to the evaluation electronics.

The continuity check is suitable both for analog and digital ICs, the fault detection probability being independent of the internal function of the IC. The following **faults can be detected:**

- broken tracks,
- non-connected IC pins (soldering defects), also for bus ICs,
- missing supply and ground pins,
- missing ICs,
- ICs with wrong polarity,
- ICs using other technologies (eg TTL instead of CMOS),
- incorrect insertion (eg flipflop 7474 instead of gate 7400) can however only be detected under favourable conditions.

The test does not check the function of an IC. Moreover, there is a certain susceptibility to manufacturing spreads. Since unspecified, parasitic characteristics are used for the measurement, the results may differ if the component supplier is changed. Though in some cases such a change may be desirable, this can however lead to unwanted pseudo faults.

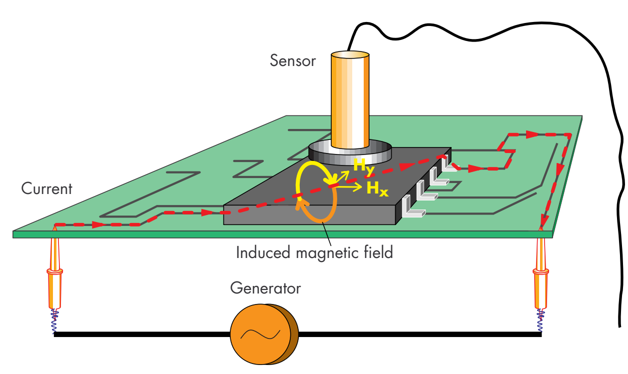


FIG 1
Measurement of current flow direction by means of magnetic field

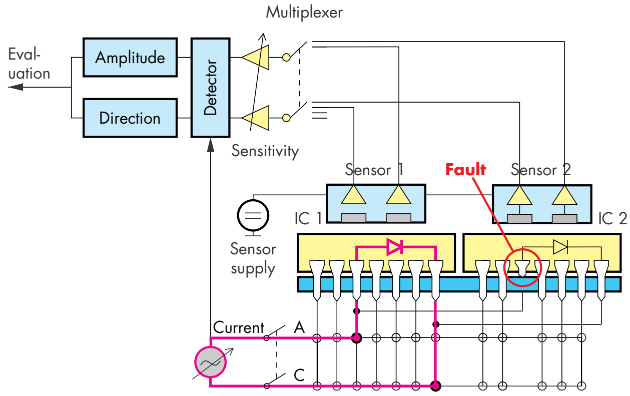


FIG 2
Test setup and
sensor selection

Cocheck II analyzes the **current in amplitude and direction.** Technological (different manufacturers) and mechanical spreads (eg uncertain distance of the sensor from the substrate due to different thickness of the casing or slanted position) can be taken into account by wider tolerances. This affords a reliable threshold margin for the pass/fail decision. In particular incorrect insertions are often recognized by the drastic change in the current flow direction, since the current flows to another pin while the magnitude is still within tolerance.

Cocheck II is especially suitable for the **diagnosis of contacting faults on buses** since in contrast to ICC (IC check [2]) diagnosis is possible at the IC pin level and not only at node level. This means however a greater hardware outlay with a sensor required for each IC. In many cases it is sufficient to provide sensors only for the few complex, high-pincount ICs with fine pitch.

Operation

Program generation is semi-automatic with the interactive test generator of the tester. The nodes are entered for each IC. The test generator automatically learns the optimum stimuli and tolerances and generates a nominal data set for each IC pin. In the subsequent debugging phase the values are verified on different samples and the tolerances widened, if necessary. After the debugging phase a complete program is available which can be added to the in-circuit test program. The convenient user interface with automatic learning, comparison of measured with nominal values, the independent selection of parameters for each pin and the analysis of the magnetic field in magnitude and direction are essential criteria in fault detection.

Fixtures

Commercial **bed-of-nails fixtures,** eg vacuum fixtures, can be used. The sensors are soldered to nails above or below the ICs. These nails are inserted and wired as usual. For components inserted on the solder side the moving plate has to be cut out. For ICs inserted on the components side, the fixture is provided with a cover on which sensors are mounted for each IC to be tested. After closing the cover, the spring-loaded sensors exert pressure on the ICs such that bad soldering joints will not become closed by excessive pressure.

Cocheck II uses extremely **low-cost and reusable sensors** which are independent of the IC design.

Economy

Cocheck II offers a budget-priced way of testing the insertion of digital and analog ICs on an analog in-circuit tester involving a single test module and slight adaptation of the fixture. Where digital testing has already been implemented, the adaptation costs and times can be reduced by omitting the generation of a model. With a standard, low-cost sensor for all ICs, fixture costs can be kept low.

Dr. Lothar Tschimpke

REFERENCES

[1] Tschimpke, L.: Test Workstation TSA for testing in electronics production and service. News from Rohde & Schwarz (1991) No. 132, pp 4–7

[2] Tschimpke, L.; Huber, J.: In-circuit-Test: Fehlersuche auf anderen Wegen. Elektronik (1993) No. 22, pp 102–107

[3] Tschimpke, L.: LaserVision System LV1 – Optical insertion testing combined with classic board test. News from Rohde & Schwarz (1995) No. 150, pp 10–12

[4] Tschimpke, L.; Kundinger, K.: Universal Test System TSU – Versatile test platform for production and service of electronic modules. News from Rohde & Schwarz (1995) No. 150, pp 13–15

Reader service card 154/10

Coherence analysis in audio technology

FIG 1 Measurement of coherence and transfer function on hearing aid using Audio Analyzer UPL Photo 42 642

Digital signal processing allows new technical features to be implemented in the field of audio, like for instance reduction of the stored or transmitted audio data by utilizing the masking effects of the ear (MPEG). To achieve the desired perception, signals can be modified accordingly with the aid of digital signal processing. This may be obtained for instance with effect processors and declickers in the studio as well as with intelligent hearing aids, in which the gain is varied either frequency-selectively or depending on the type of signal.

These systems, whose characteristics are mainly determined by dynamic processes, evade validation by conventional measurements since the latter normally use stationary, ie time-invariant test signals. Such stationary test signals however do not activate the dynamic characteristics, so that faults upon a status change of the device under test are not detected. For remedy, there are two possible solutions:

1. Development of a special test signal and associated test method for a certain dynamic characteristic.
2. A test method that is independent of the type of signal and able to measure the desired parameter with practically all test stimuli.

Coherence analysis belongs to the second group. With this method the cross-correlation between input and output signal of the DUT is formed and divided by the relevant FFTs (fast Fourier transforms) of the input and output signals; for all frequency values only the magnitude but not the phase is considered. The **coherence γ^2** is calculated according to the following formula:

$$\gamma^2 = \frac{|\text{channel 1 x channel 2}|}{|\text{FFT(channel 1)}| \times |\text{FFT(channel 2)}|}$$

If this calculation is carried out just once for any type of input signal, γ^2 will be 1 because of magnitude computation. This means that the average has to be taken over several successive measurements; the cross-correlation in the numerator is however averaged prior to computing the magnitude, whereas the normalization in the denominator is made thereafter. If the phase of a certain frequency line between input and output signal is constant in each measurement, the terms in the nominator will be summed. If however the phase is arbitrary (eg due to superimposed noise), the terms are averaged as follows:

$$\gamma^2 = \frac{|\sum_n \text{channel 1 x channel 2}|}{\sum_n |\text{FFT(channel 1)}| \times \sum_n |\text{FFT(channel 2)}|}.$$

The following **characteristics** are thus obtained **for γ^2**:

- γ^2 is a function of frequency, the resolution of which depends on the size of both the FFT and the cross-correlation.
- γ^2 is always ≤ 1, since the nominator can never become greater than the denominator.
- If statistically the output signal is independent of the input signal, cross-correlation averaging approaches zero.
- If statistically the output signal is dependent on the input signal (no superimposed noise), the individual cross-correlation components will be superimposed on each other at a certain frequency as a result of averaging. It should be noted that this also holds true for the time-variant gain of the DUT, the frequency response of the DUT being again irrelevant; and $\gamma^2 = 1$ in this case.

γ^2 is also a measure of the transmission fidelity, ie how far the output signal of a DUT is determined by the input signal and how much it is affected by external influences (noise, etc). Coherence analysis is independent of the test signal, and merely the activation of the frequency ranges of interest is necessary. This means that voice, voice-simulating noise, music or broadband noise can be used. It is of course advisable to use signals that are critical for the DUT.

As a spinoff of the above, the transfer function of the DUT is calculated as follows:

$$|H(f)| = \frac{\sum_n |\text{FFT(channel 1)}|}{\sum_n |\text{FFT(channel 2)}|}.$$

Coherence analysis finds **application** wherever the gain is varied depending on the signal. It can also be used to prove band clipping or gaps in a frequency range. In the frequency gaps, the causal connection between input and output signal is no longer given and the coherence value decreases. A practical application example of coherence analysis is in hearing aid measurements. The test setup with

Audio Analyzer UPD or UPL [1; 2] shown in FIG 1 is used for this purpose. A multitone signal whose frequency spectrum is appropriate for the frequency resolution of the analysis is chosen as the generator signal. Equalization of the frequency components to compensate for the frequency response of the test chamber can simply be effected by connecting the equalizer integrated in UPD/UPL to the generator output, which then directly feeds the loudspeaker in the test chamber. The reference microphone picks up the input signal of the hearing aid. The output signal is detected via a 2-cm^3 coupler in line with IEC126 or an ear simulator in line with IEC118 and IEC711 suitable for the adaptation of a calibrated standard microphone.

Analyzer UPD/UPL is set to two-channel measurement by selecting the COHERENCE function. An appropriate setting is for instance 2048 testpoints in FFT and an averaging depth of 30. Upon completion of the measurement, the transfer and coherence characteristics shown in FIG 2 are obtained.

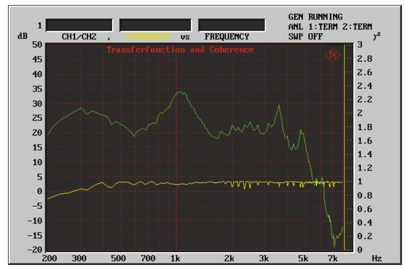


FIG 2 Printout of transfer function and coherence measurement

The measurement described will be specified in the future ANSI S3.42 and IEC draft TC29 standards. Due to the versatile design of Audio Analyzers UPD and UPL this measurement can be made with all models of any serial number without any hardware modifications. All that is required for UPL is software option UPL-B6. For UPD, coherence analysis is included in the basic software from version 3.0.

Wolfgang Kufer

REFERENCES

[1] Kernchen, W.: Audio Analyzer UPD generates and measures analog and digital audio signals. News from Rohde & Schwarz (1992) No. 139, pp 13–15

[2] Kernchen, W.: Audio Analyzer UPL – Audio analysis today and tomorrow. News from Rohde & Schwarz (1996) No. 151, pp 4–6

Reader service card 154/11

Long-term monitoring of sound-broadcast and TV transmitters

Like equivalent organizations in other countries, German broadcasting and media companies as well as the Federal Post and Telecommunications Office (BAPT) have the duty to continuously monitor transmitter parameters*. **Transmitter Monitoring System SMSA** from Rohde & Schwarz is a simple and cost-effective solution to perform this task. It not only monitors the limits for field strength, modulation, frequency offset and bandwidth but also transmitter breakdowns. Any deviation from nominal is immediately signalled as an alarm message at the test site or signalled to remote receiving stations.

The core of Transmitter Monitoring System SMSA is Spectrum Monitoring Software ARGUS, Test Receiver ESVN40 (9 kHz to 2.75 GHz) or ESVN20 (20 MHz to 1 GHz) and a process controller (FIG 1). For measuring vertically polarized signals in the frequency range 20 MHz to 1 GHz, Antenna HE309 is directly connected to Test Receiver ESVN20. If several an-

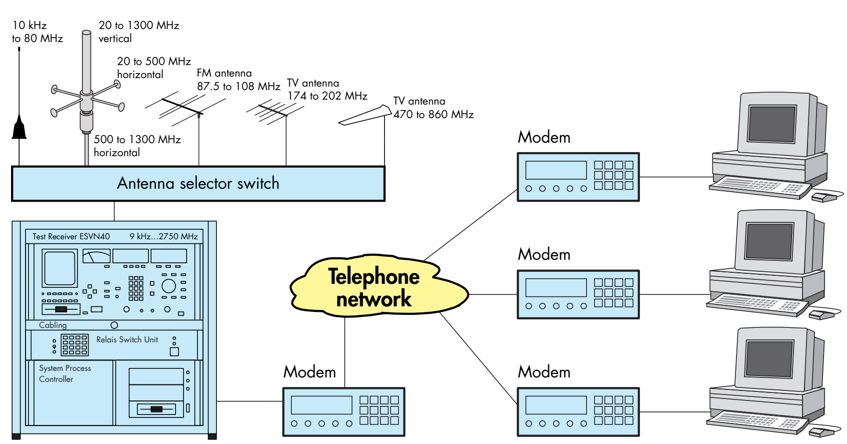


FIG 1 Configuration of Transmitter Monitoring System SMSA

* Seidl, W.D.: Spectrum monitoring the ITU way. News from Rohde & Schwarz (1997) No. 153, pp 26–27

FIG 2
An antenna system of Transmitter Monitoring System SMSA
Photo: Pfitzner

tennas are used (extended frequency range, vertical or horizontal polarization, omnidirectional or directional, active or passive), they (FIG 2) are changed over by means of an antenna selector switch. Alarm messages are transmitted via the public phone network if several receiving stations have to be informed or if the test station is unattended. Up to three alarm controllers can receive information about deviations of the transmitter parameters.

For monitoring to be of real value the parameters of all the channels should be measured simultaneously in the shortest possible time. Transmitter Monitoring System SMSA monitors the field strength, modulation (AM and FM) and frequency offset of, for example, ten TV and 40 sound broadcasting channels at a repetition rate of 3 s (without antenna switchover) or 20 s (with switchover between eleven different antennas).

With **Spectrum Monitoring Software ARGUS** the user can define individual limits for the various parameters of each transmit channel. If any of these limits is violated, an alarm message will be issued immediately:

- For the **field strength,** there is a tolerance range, ie if the field strength falls below the lower limit, a transmitter breakdown will be signalled. If the upper limit is exceeded, an impermissible transmit power will be indicated.
- This is also valid for the **frequency offset.** A deviation from the permissible tolerance range is signalled as erroneous operation.
- For **modulation** and **bandwidth,** there are only upper limits.

To avoid alarms being triggered every time a stray value occurs, measurements have to lie outside the tolerance range several times and in a sequence. The number of stray values actually triggering an alarm can be set by the user between one and 1000: a reasonable value would be three. An OK message will be signalled if the limit values are adhered to again (eg following a temporary transmitter breakdown).

This procedure will be illustrated by way of an **example:** the field strength on a channel is measured every 5 s. The number of tolerated limit violations before an alarm is triggered shall be three. The results together with an upper and lower limit line are displayed versus time (FIG 3). At test point 5 (after 20 s) an alarm will not be triggered since the upper limit has only been violated once. At test point 11 (after 50 s), the upper limit is violated again. An alarm message however will not be triggered until test point 13 (after 60 s) is reached since the number of tolerated limit violations was defined as three (3). The alarm message issued relates to the status of test point 11, ie when the problem occurred for the first time. From test point 18 (after 85 s) the measured values are again within tolerance. The OK message will be sent from test point 20 (after 95 s) since three alarm messages have again been attained. The data of the OK message refer to the field strength at test point 18.

Alarm messages are directly output at the process controller or will be sent via a modem. If only one alarm message occurs, it will be sent to one or several alarm controllers via the public phone network. The messages will be displayed there as shown in FIG 3 or may be printed out (for test report see blue field).

The status information reveals whether a measured value is above the upper limit, below the lower limit or again within tolerance with the latter being indicated by the OK message. Moreover, an alarm can also trigger further actions in the test system: 1. an additional measurement will be carried out and logged (eg bandwidth measurement), 2. a signal tone will be generated (for unattended stations).

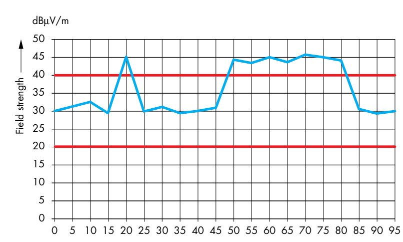


FIG 3 Results curve for field strength (blue); limit lines in red

Transmitter Monitoring System SMSA thus reliably fulfills tasks required for the continuous monitoring of transmitters. It supports the responsible bodies and organizations to eliminate the problems before the first complaints from listeners or viewers come through.

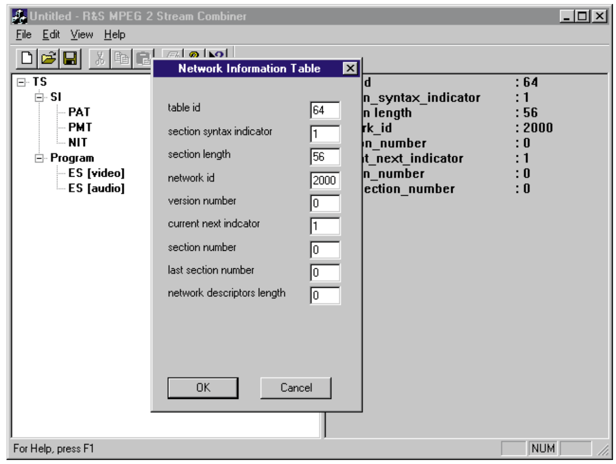
Jörg Pfitzner; Wolf D. Seidl

Message	Date	Time	Frequency	Limit	Measured value	Test parameter	Status	Comment from frequency list
Alarm	14.03.97	12:00:50	98.500000 MHz	40 dBµV/m	44 dBµV/m	Level	High	Bayern 3
Alarm	14.03.97	12:01:25	98.500000 MHz	40 dBµV/m	31 dBµV/m	Level	OK	Bayern 3

Reader service card 154/12

PC software for MPEG2 dream team DVG/DVMD

The two software products Stream Combiner (option for MPEG2 Generator DVG) and Stream Explorer (option for MPEG2 Measurement Decoder DVMD) allow very flexible handling of MPEG2 transport streams. Variation and analysis of data streams is possible down to bit level and overview is guaranteed thanks to the user-friendly Windows interface.



Editing network information table with Stream Combiner software

MPEG2 Generator DVG* is especially popular because of its ease of operation and applications: you simply switch it on, select the desired transport stream, and the MPEG2 signal is promptly available. All this is possible with a single unit without a PC, encoder or multiplexer being required. The transport streams supplied by DVG cover the most common types of application. With the **Stream Combiner** software, users with individual applications now have a tool to generate their own specific transport streams by combining elementary streams and by configuring system parameters (FIG). The software offers the following functions:

- Compilation of new transport streams from the supplied elementary stream library; all the elementary streams are coded in a special way such that they can be multiplexed to an endless data flow in DVG.
- Insertion of user-specific elementary streams (MPEG2-coded data files).
- Free creation of MPEG2 system parameters (ie selecting PIDs, editing PAT and PMT, setting the repetition rates of tables).
- Selection and edition of service information including all DVB tables and their descriptors (eg program name and supplier).
- Generation of specific errors or nonconformal states in the transport stream.

Windows software **Stream Explorer** supplements the functions of **MPEG2 Measurement Decoder DVMD*.** While the concept of DVMD is tailored to the realtime analysis of MPEG2 transport streams in compliance with MPEG2 and DVB, Stream Explorer is intended for the detailed analysis of the structure, contents and system parameters of transport streams. To this effect, it evaluates transport stream data provided by DVMD to the PC. A great variety of data filtering as well as access to preprocessed data stored in DVMD provide fast and clear results. The results shown in graphics or tables relate to the MPEG2 transport stream applied to DVMD.

The Stream Explorer **functions** are concentrated on the following three areas:

- **Representation and interpretation of stream contents;** forms of representation are the tree structure for the whole transport stream and the hexadecimal display of individual transport stream packages. The detailed but clear representation for all syntax elements of a transport stream is of central interest.
- **Trigger on error;** Stream Explorer makes use of this function supported by DVMD. If a trigger event occurs in the applied transport stream, the data in the area of the irregularity will be stored in the measurement decoder and sent to Stream Explorer for evaluation.
- **Visualization of system parameters of transport stream;** in addition to the structure and contents, Stream Explorer also displays the system parameters of the transport stream by means of the bar and trace diagrams. Data rates of the elementary streams or the jitter of the time references are typical examples. Moreover, it is possible to display and monitor the buffer fullness of the system target decoder as defined in MPEG2.

Besides these functions Stream Explorer supports the full remote control of DVMD. DVMD, originally conceived for monitoring tasks, is upgraded by Stream Explorer to a versatile instrument for the comprehensive and detailed analysis of MPEG2 transport streams.

Michael Fischbacher; Werner Rohde

* Fischbacher, M.; Weigold, H.: MPEG2 Generator DVG and MPEG2 Measurement Decoder DVMD – Test equipment for digital TV in line with MPEG2. News from Rohde & Schwarz (1996) No. 152, pp 20–23

Reader service card 154/13

Digital modulation and mobile radio (V)

3.2 Minimum shift keying and Gaussian minimum shift keying

3.2.1 Mathematical derivation of MSK

When it formulated the GSM standard, the standards committee chose a different approach and stipulated angle modulation with a constant envelope of the RF signal for digital networks. This means that the length of the vector representing the RF signal does not change as it turns through an angle of $\Delta\varphi$ from $\varphi(t_1)$ to $\varphi(t_2)$ over a time interval equal to the bit duration. The end of the vector must, therefore, describe the arc of a circle with an angular speed of $\frac{d\varphi}{dt} = \frac{\Delta\varphi}{T_{bit}}$. After turning through this angle, during which a symbol is transmitted, the vector does not remain stationary in the position it has reached but continues to turn in the same direction, so repeating the signal that has been transmitted, or turns in the opposite direction, so sending the opposite of the transmitted bit.

The phase change of the RF signal with respect to the arbitrary zero phase of the unmodulated carrier is associated with a frequency change of Δf. The instantaneous frequency and the frequency deviation can be calculated from the first derivative of the carrier phase, in other words from the derivative of the argument of the cosine function describing the carrier.

Modulation index h	Frequency deviation Δf	Phase shift over bit duration T_{bit}	Correlation factor ρ	Euclidean distance D
0.5	$\frac{1}{4\,T_{bit}} = \frac{1}{4} f_{bit}$	$\frac{\pi}{2} = 90°$	0	$\sqrt{2E_{bit}}$

TABLE 3 MSK parameters

If the phase change $\Delta\varphi$ that occurs over the duration of a bit is expressed as a multiple h of π, h being referred to as the modulation index, the following relations are obtained:

$$\begin{aligned}\Phi(t) &= 2\pi f_c t + \varphi(t)\\ &= 2\pi f_c t + \varphi_0 \pm \frac{2\pi h}{2T_{bit}}\,t,\end{aligned}$$

$$\begin{aligned}\frac{d\Phi(t)}{dt} &= 2\pi f_c + \left(\frac{d\varphi(t)}{dt}\right)\\ &= 2\pi f_c \pm 2\pi\Delta f\\ &= 2\pi f_c \pm \frac{2\pi h}{2T_{bit}};\end{aligned}$$

$$\Delta f = \frac{h}{2T_{bit}};$$

$$\varphi(t) = \varphi_0 \pm \frac{2\pi h}{2T_{bit}}\,t; \quad \Delta\varphi = h\pi \qquad (19)$$

The signals representing the symbols 0 and 1 can then be expressed as:

$$\begin{aligned}s_1(t) &= A \cdot \cos\left(2\pi\left(f_c + \frac{h}{2T_{bit}}\right)t\right)\\ &= A \cdot \cos(2\pi(f_c + \Delta f)t)\end{aligned}$$

and

$$\begin{aligned}s_2(t) &= A \cdot \cos\left(2\pi\left(f_c - \frac{h}{2T_{bit}}\right)t\right)\\ &= A \cdot \cos(2\pi(f_c - \Delta f)t) \qquad (20)\end{aligned}$$

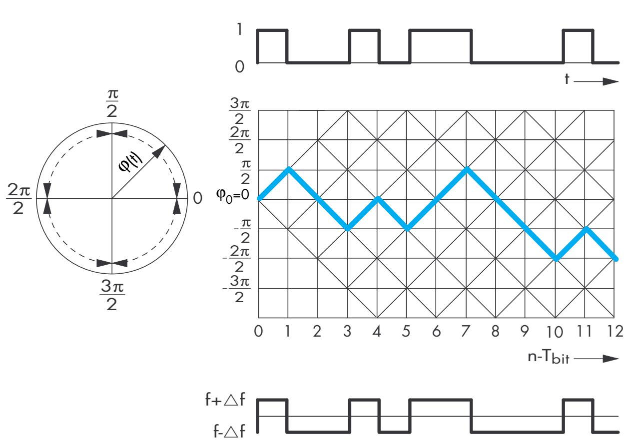


FIG 10 Relationships between data signal, frequency and phase for minimum shift keying

These equations describe frequency keying (see equation 12). Because the phase changes continuously, this type of modulation is referred to as continuous phase frequency-shift keying (CPFSK). FIG 10 shows the correlations between the data sequence, current phase and current frequency. The trellis diagram which shows the possible phase transitions also explains why a CPFSK modulator has a memory. It is easy to see how the current phase depends on previous states.

Equation 13 gives the following expression for the correlation factor of the two signals $s_1(t)$ and $s_2(t)$:

$$\rho = \frac{\sin(\pi \cdot h)}{\pi \cdot h} - \frac{\sin(2\pi f_c T_{bit})}{2\pi f_c T_{bit}} \qquad (21)$$

If $f_c \gg 1/T_{bit}$, the second term can be neglected. Uncorrelated signals ($\rho = 0$) are obtained when $h = k \cdot 0.5$ where $k \in \{1, 2, 3, \ldots\}$; $h = 0.5$ is therefore the smallest modulation index for which the two signals are uncorrelated. FSK with h = 0.5 and $\Delta f = \frac{1}{4\,T_{bit}} = \frac{1}{4} f_{bit}$ is therefore also referred to as minimum shift keying (MSK). TABLE 3 summarizes the main parameters for this type of modulation once more.

3.2.2 Implementing MSK

The simplest way of producing an MSK signal would be to convert the data sequence a(n) into a bipolar NRZ signal which is then used to control a VCO (FIG 11). This approach is in fact adopted for, say, cordless phones where the specifications for the frequency and angle accuracy of the

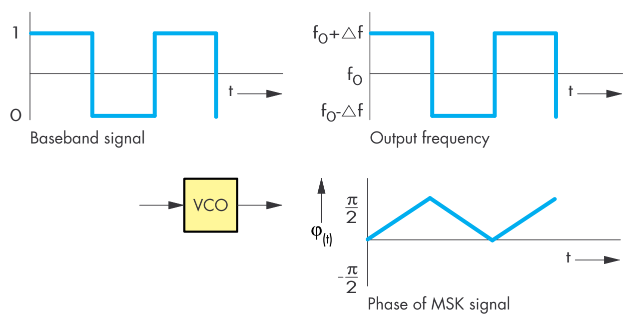


FIG 11
Generating minimum shift keying with VCO

modulated signal do not have to be so stringent. However, the GSM specifications for the maximum frequency and angle error during a burst are so tight that a VCO would be incapable of meeting them. An I/Q modulator gives better results under these restraints. Before analyzing a modulator of this kind, it will be useful to briefly review the I/Q notation used for modulated RF carriers once more.

$$\begin{aligned} s(t) &= A \cdot \cos[2\pi f_c t + \varphi(t)] \\ &= A \cdot [\cos(\varphi(t)) \cdot \cos(2\pi f_c t) \\ &\quad + \sin(\varphi(t)) \cdot (-\sin(2\pi f_c t))] \qquad (22) \end{aligned}$$

The RF signal has two mutually orthogonal components $\cos(2\pi ft)$ and $-\sin(2\pi ft) = \cos(2\pi ft + \pi/2)$ which are multiplied by the functions $\cos\varphi(t)$ and $\sin\varphi(t)$ by means of, say, two double-balanced mixers. The angle $\varphi(t)$ can be obtained from equation 19 and is given below:

$$\varphi(t) = \varphi(nT_{bit}) \pm 0.5\pi/T_{bit} \cdot t^* \qquad (23)$$

with $0 < t^* < T_{bit}$

In practise, the modulated carrier can be obtained in the following way:

1. Obtain the two mutually orthogonal carrier components $I(t) = \cos(2\pi ft)$ and $Q(t) = -\sin(2\pi ft)$.
2. Multiply the I component with $\cos\varphi(t)$ and the Q component with $\sin\varphi(t)$.
3. Add the two components.

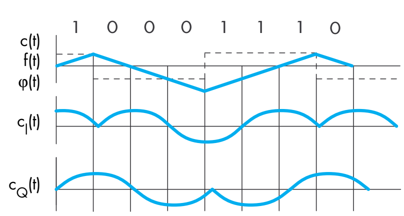


FIG 12 Modulation signals and I/Q signals for MSK

The next problem is the generation of the modulating signals $\cos\varphi(t)$ and $\sin\varphi(t)$. This cannot be done with classic analog methods, the signals have to be calculated digitally using equation 23 for the time $nT_{bit} < t^* < (n+1)T_{bit}$, the polarity of the fraction determining whether a 1 or a 0 is sent.

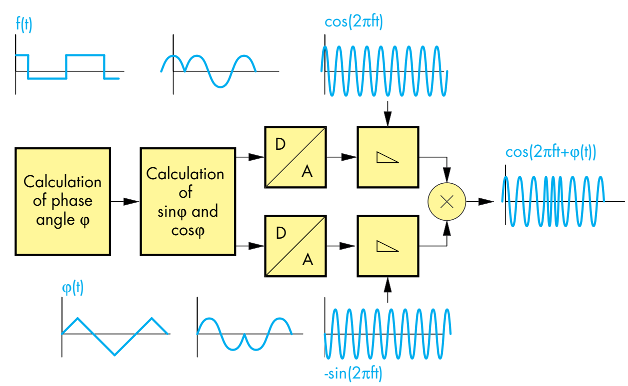


FIG 13
I/Q modulator for MSK

If the data sequence a(n) is mapped onto the data function

$$c(t) = c(nT_{bit} + t^*) = \begin{cases} +1 \text{ for } a(n+1) = \text{“1”} \\ -1 \text{ for } a(n+1) = \text{“0”} \end{cases} \qquad (24)$$

(23) can be rearranged to give

$$\varphi(t) = \varphi(nT_{bit}) + c(t) \cdot \frac{0.5 \cdot \pi}{T_{bit}} t^* \qquad (25)$$

This yields:

$$c_I(t) = \cos(\varphi(nT_{bit})) \cdot \cos\left(\frac{\pi}{2\ T_{bit}} t^*\right)$$

$$- c(t) \cdot \sin(\varphi(nT_{bit})) \cdot \sin\left(\frac{\pi}{2\ T_{bit}} t^*\right)$$

and

$$c_Q(t) = \sin(\varphi(nT_{bit})) \cdot \cos\left(\frac{\pi}{2\ T_{bit}} t^*\right)$$

$$+ c(t) \cdot \cos(\varphi(nT_{bit})) \cdot \sin\left(\frac{\pi}{2\ T_{bit}} t^*\right) \qquad (26)$$

The following approach is used:

1. Start with an initial phase. If $\varphi(0) = 0$ is selected, equation 26 gets less complex: $\sin(\varphi(nT_{bit}))$ becomes 0, $\cos(\varphi(nT_{bit}))$ becomes ± 1.
2. Calculate $\varphi(t)$ (for example by using a digital accumulator).
3. Calculate the functions of time $c_I(t)$ and $c_Q(t)$ from tables.
4. Calculate the phase $\varphi(nT_{bit})$, (last accumulator value in 2).
5. Go to 2.

FIG 12 shows this procedure for eight consecutive bits; FIG 13 shows how the modulator operates. The bipolar NRZ signal is proportional to the instantaneous output frequency $f_c \pm \Delta f$ of the modulator. In the accumulator it is integrated to give a signal that is proportional to the instantaneous phase of the modulated carrier. Tables for $\sin\varphi(t)$ and $\cos\varphi(t)$ provide the signals $c_I(t)$ and $c_Q(t)$ in digital form. After D/A conversion and analog filtering by a lowpass, these signals are fed to the modulators at whose RF inputs the orthogonal components of the carrier have been applied. The two modulated carrier components are added in a power summer to give the output signal. If you consider the I/Q modulator from the point where the bipolar NRZ signal is fed into the RF output, it acts as a frequency modulator or a VCO.

To be continued. Peter Hatzold

Better HF radiocommunications for smaller vessels with Marine Dipole HX002M1

150-W Marine Dipole HX002M1 (1.5 to 30 MHz) features extremely low weight, small size and robust design. Photo 42 826/1

With shortwave propagation over the sea, **groundwave communications** can be established over considerably long distances; with ship-to-ship communications on the high seas it may even be possible to cover several hundreds of kilometers, depending on the transmitter power and bandwidth. In coastal areas and for ship-to-land communications, the groundwave coverage range becomes distinctly shorter. When the signal crosses the sea-land interface several times, there is a dramatic drop in field strength. The shadow effects behind islands are well-known and can hardly be avoided where vertically polarized waves are radiated to cover short and medium distances exclusively by means of groundwaves.

The solution to this problem is **high-angle radiation** via the ionosphere (NVIS). Using appropriate transmitting and receiving antennas and selecting a suitable frequency, any distance can be covered [1]. Due to the limited space available onboard ships, suitable high-angle antennas are usually unbalanced wire antennas, loop antennas and balanced dipoles.

Unbalanced wire antennas predominantly used in the past are usually fed from a slanting feed line which in addition to the desired horizontally polarized wave also generates a vertically polarized wave. This however entails a number of disadvantages: part of the transmitter power is not utilized for the intended transmission. Moreover, there is a zone of confusion in which groundwave and skywave arrive with approximately the same field strength; reception is impaired through interference of these two types of waves. Position and size of this interference zone depends on place and time. Finally, the vertically polarized field causes stronger interference to shipborne systems than the horizontally polarized field. In view of the difficult EMC situation onboard ships, vertically polarized emissions should therefore be avoided wherever possible.

In addition to high-angle radiation, **loop antennas** also radiate vertically polarized signals so that the disadvantages are the same as with the unbalanced wire antennas. Moreover, normal-size loop antennas have low efficiency with the result that less power is radiated, especially at the low frequencies occurring at night. Although this effect improves the EMC conditions – where there is little radiation there are also less EMC problems — it is obviously at the expense of radio link reliability.

1-kW **horizontal balanced dipoles** have already proven themselves onboard larger vessels. With HX002M1 (FIG) Rohde & Schwarz is now offering another HF dipole with integrated tuning unit, which thanks to its length of only 5 m and low weight is suitable for use on medium-sized and small ships. The dipole is designed for a transmitter power of 150 W, which is mainly used on such ships and which calls for a high-efficiency antenna.

Through concentration of the available power on high-angle radiation, radio transmission is considerably improved by HX002M1 as compared to systems using the other types of antennas mentioned above. Especially the comparison with loop antennas shows a distinctly higher link reliability, above all during the critical night time. Moreover, horizontal polarization of the radiated waves improves the EMC situation onboard. Like the 1-kW dipoles, HX002M1 features a robust and extremely corrosion-resistant design to protect it against the harsh environmental conditions onboard ships; shock, vibration and salt spray tests in line with relevant specifications have proven the suitability of HX002M1 for use on ships.

For shortwave radio stations on land, the tried and tested balanced HF Dipoles HX002A1 for 150 W [2] and HX002 for 1 kW with the same quality features are available.

Axel Stark

REFERENCES

[1] Stark, A.: Propagation of electromagnetic waves (R&S reprint)

[2] Demmel, F.; Klein, A.: 150-W HF Dipole HX002A1 – The antenna for reliable shortwave links. News from Rohde & Schwarz (1996) No. 150, pp 29–31

Reader service card 154/14

New option for fast compression-point measurements with Vector Network Analyzer ZVR

An essential parameter for describing the linearity of an electronic circuit is the compression point (CMP) in addition to the intermodulation points (IP_2 and IP_3). Measurement of the 1-dB compression point, for instance, used to be a complex procedure until now. First, the small-signal gain of the device under test has to be determined for each frequency point. Then the input power is successively increased and the output power checked at the same time for linear increase with the input power. This has to be continued until the power reaches a value at which the measured gain, ie the ratio between output and input power, is 1 dB lower than the small-signal gain. The 1-dB compression point has thus been found for this frequency point and can be determined in the same way for the next one. Manual performance of this measurement is a laborious task, takes a lot of time and is liable to errors.

The nonlinear measurements option (ZVR-B5) available for the vector network analyzers (FIG 1) of the ZVR family [1; 2] automatically performs the complete measurement procedure with high speed simply at a keystroke. Measurement of the compression point is activated via the mode menu of ZVR. Enhancement label CMP lights up to the right of the diagram. Generally, the x-dB compression point can now automatically be determined, with any value between 0.1 and 10 dB being selectable for x. In addition to the compression point referred to the output, the compression point referred to the input can be indicated just as easily. The result obtained is a trace nearly in realtime (3 s for 201 frequency points) similar to that of an ordinary power or S-parameter measurement. In this case however the trace is a continuously updated display of the selected compression point versus frequency which allows fast alignments in the laboratory or in production.

FIG 2 shows typical measurement results obtained for a commercial type of integrated amplifier. The red trace represents the 1-dB compression point of the amplifier referred to the output, measured in a frequency range from 50 MHz to 1.6 GHz and found to be about 15 dBm. The small-signal gain at an input power of –36 dBm was also measured. The blue trace shows that the small-signal gain drops from about 32 dB at low frequencies to 21 dB at 1 GHz (marker 2). Furthermore, the compression point referred to the input was determined and shown as a green trace. As expected from theory, the frequency characteristic is a rising function and approximately inverse to the small-signal gain.

FIG 1 Vector Network Analyzer ZVR, the all-rounder for network analysis Photo 42 255/2

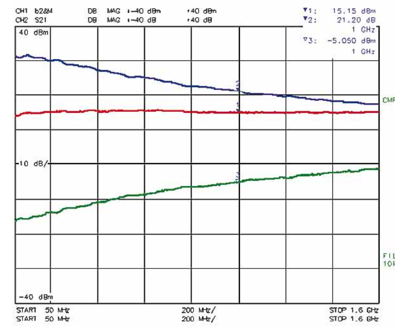


FIG 2 Automatic compression-point measurements with Vector Network Analyzer ZVR and nonlinear measurements option. Test results of integrated amplifier: small-signal gain (blue), 1-dB compression point at output (red) and 1-dB compression point at input (green)

Using an external source, the 2nd- and 3rd-order intermodulation points can also be measured with the aid of option ZVR-B5 in a similarly easy and fast way.

Dr. Olaf Ostwald

REFERENCES

[1] Ostwald, O.; Evers, C.: Vector Network Analyzer Family ZVR – To the heart of the chart. News from Rohde & Schwarz (1996) No. 150, pp 6–9

[2] Danzeisen, K.: Frequency-selective measurement and display of frequency-dependent test parameters. News from Rohde & Schwarz (1996) No. 152, p 47

Reader service card 154/15

CATV Headend System CT200 supplies Liechtenstein with sound-broadcast programs

FIG 1 View of cable headend of Liechtensteinische Grossgemeinschaftsantennenanlage (LGGA) in Vaduz Photo 42 827/1

The cable headend installed by Rohde & Schwarz in Vaduz for the Liechtensteinische Kabelgesellschaft is now supplying the whole country with sound and TV programs. Since reception is extremely difficult due to the geographics of Liechtenstein, several receiving stations had to be set up integrating the control system into the main station. More than 50 analog TV programs, three digital TV packages, 31 VHF FM programs, a country-specific channel for the transmission of parliament sittings using a fixed camera, and a local service channel for district council sittings are fed into the network.

The cable headend is equipped with components of CATV Headend System CT200*. Thanks to the modular design of this system, the complete equipment can be accommodated in only eight 19″ racks (FIG 1) and there is still enough room left for extensions. Every rack is controlled and monitored by a separate controller. Different active and passive combiners allow various module combinations.

Troublefree operation of the CATV network is indispensable – not only because of the competition from other satellite operators – and so the reliability of the CT200 system has been given top priority. CT200 is the only system worldwide which monitors the module under test in every detail. Each module has a microprocessor allowing module-to-controller communication via a system-internal bus. The microprocessor not only carries out controlling, it also provides test data and thus makes elaborate test routines for certain applications unnecessary. In practice, this means that all the changes are registered and that response times are extremely short.

The continuous monitoring of certain tolerance ranges means that a kind of permanent check-up is made. System-relevant parameters (eg level, frequency drift) can be defined as default values by the user; the processor of the device responds with a corresponding message. All the drifts are logged over a certain period of time and, if a more accurate analysis is required, can be displayed and printed out any time. All parameters are logged continuously.

Operational reliability is complemented by a n+1 standby system which is currently the fastest, most effective and attractively priced switchover system worldwide. The controller decides about switchover in a couple of seconds without any measurements being required. Switchover is possible at different signal levels and depends on the requirements and philosophy of the cable network operator.

The interactive Windows user interface of the system software can be managed very easily by anyone especially as the complete system is displayed graphically. By clicking the graphic elements using the mouse the user can go deep-down into the system and modify any setting or parameter whenever required. A password is of course required to access the system and all accesses are logged.

The main station of the cable headend system in Vaduz controls and monitors the two receiving stations Sücka and Gaflei that are difficult to access with cable modems via the broadband coaxial cable (FIG 2). The advantages of this solution are evident: high transmission rates, no point-to-point lines, low costs, permanent connection between the CPU in the main station and the external stations.

Special frequency-relevant measures were required because the receiving stations (as seen from the headend) are located one behind the other and the whole data transfer from Sücka has to

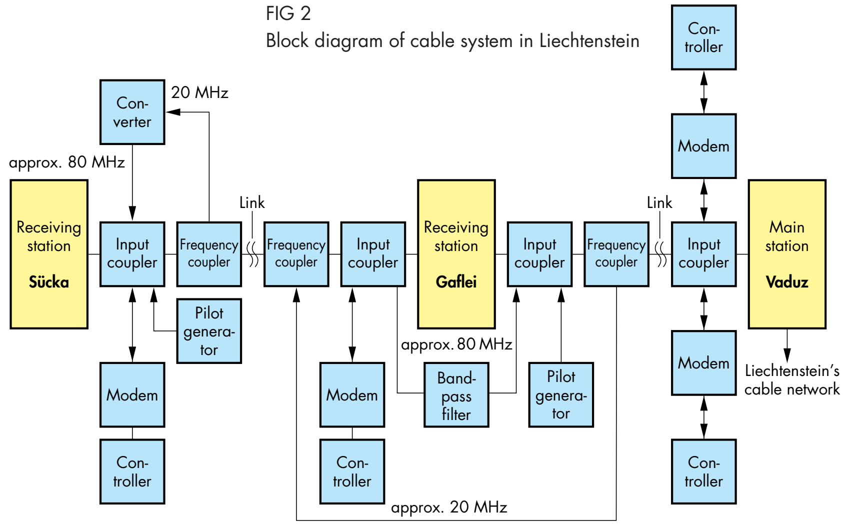
* Schönberger, P.; Sturm, P.; Scheide, R.: CATV Headend System CT200 – CATV signal processing intelligent, compact, versatile. News from Rohde & Schwarz (1995) No. 148, pp 23–25

be organized via Gaflei. But CATV Headend System CT200 from Rohde & Schwarz solved all the problems connected with the difficult receiving conditions, continuous monitoring and (n+1) standby and a large number of programs intelligently, easily and economically.

Reinhard Scheide

Reader service card 154/16

FIG 2
Block diagram of cable system in Liechtenstein



Repair System SMD-RS11 – a tool for state-of-the-art servicing of printed circuits

The use of surface-mounted devices (SMDs) in electronic circuits has increased rapidly in the past few years. In some areas, their proportion in the circuitry makes up over 90%.

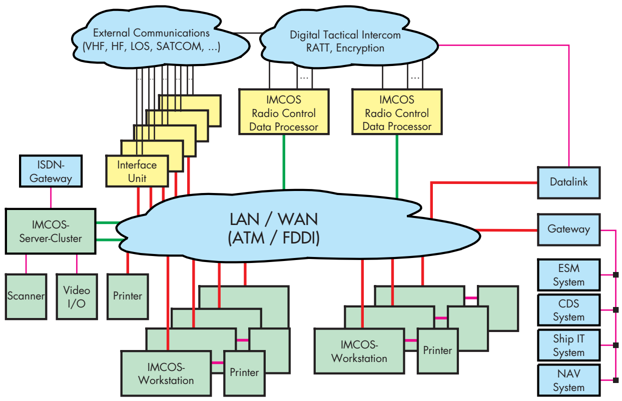
While in production soldering methods used are aimed at high throughputs per unit time, the requirements for service are of a different nature. Devices have to be soldered and desoldered without affecting the highly sensitive board circuitry. When conventional soldering techniques are used, devices and boards are often damaged. Rohde & Schwarz Cologne has developed a soldering workstation particularly designed for servicing applications: Repair System SMD-RS11 (FIG). This system assists the user in complying with the standards required by quality management, for instance the stringent MIL standards. Thanks to the wealth of experience gathered during the in-house use of the system, it can be updated to match new requirements. The user can be assured that the described technique is an optimal system solution. To date, SMD-RS11 is being used successfully by renowned companies and authorities worldwide.

Rainer Ewert

Soldering workstations with Repair System SMD-RS11 Photo: Willsch

Reader service card 154/17

IMCOS – a message handling and control system for naval forces



Integrated Message Handling and Control System IMCOS. The system platform for the application shown is based on workstations of appropriate design.

Modern naval vessels are highly complex systems not only with regard to the technologies involved, but also because of the permanent exchange of information taking place between the subsystems of the vessel and other vessels or land-based stations, which makes effective communication means essential. The information conveyed may include messages with contents following a particular format or structure, free text, fax and video. Communication is based on the use of suitable protocols (eg X.400, ACP123 and ACP127) via radio waves or lines. The volume of information communicated today is often more than what an operator can be expected to handle. Effective tools are needed to gain an overview of the situation. Bearing in mind that all communication data should in addition be archived and registered, the use of a computer-based and program-controlled information system becomes inevitable.

IMCOS from Rohde & Schwarz is a system having the described qualities (FIG). It covers all tasks essential for communication: message handling, controlling external and internal transmission equipment, automatic or manual selection of transmission equipment and of course administration of all messages in a database.

The **message handling** functions include everything required for correctly receiving and sending messages as well as editing, approving, releasing, archiving and encoding them and handling incomplete messages. It is also possible to determine certain message paths (workflows) in advance (for instance routing messages to another person in times of absence).

Controlling external and internal transmission equipment means that radio links optimally suited for the current situation are selected, configured and controlled. A number of individual functions (radio control, audio and signal matrix control, frequency and antenna management) are integrated, which makes operation much simpler. A radio link may consist of a transceiver, a modem and an encoder. The individual components of a radio link are interactively connected via the digital communications network. On land, the system may also be used with PABX or ISDN, ie with line connections.

The **transmission equipment selection** function serves for choosing the transmission equipment that will transmit a message optimally under time/cost aspects. For radio transmission, the frequency and antenna management may be used for support. This system proposes the radio link (antenna, transmission facility, power, etc) that is optimally suited for a particular situation (time of day, user location, receiver location).

The **database** serves for storing and archiving in- and outgoing messages. Data of different classification are stored in a single database without affecting sensitive data. Different levels of access for individual users guarantee protection of the data against unauthorized use.

Whether or not a system like this is taken up by the user depends largely on the **user interface.** IMCOS has been specially designed for use in military environments. All essential functions have the same graphical user interface laid out according to the principle that "what you see is what you get". This guarantees a brief period of familiarization with the system. The user is supported by an integrated online manual, a comprehensive fault message system and macros allowing the simplification of standard procedures.

Bernhard Wolf

Reader service card 154/18

Portable Industrial Controller PSP (AMD X5 (586), 133 MHz) runs under MS-Windows (3.1 or higher) or MS-DOS (6.2 or higher), is equipped with LabWindows/CVI for measurements and drivers for almost any programming language; main memory 8 (and up to 32) Mbyte, harddisk 540 Mbyte or more, disk drive, VGA graphics 640 x 480 (plus external), colour LCD 8.4" (selectable), numerous interfaces and options; AC and DC operation (eg for solar power).

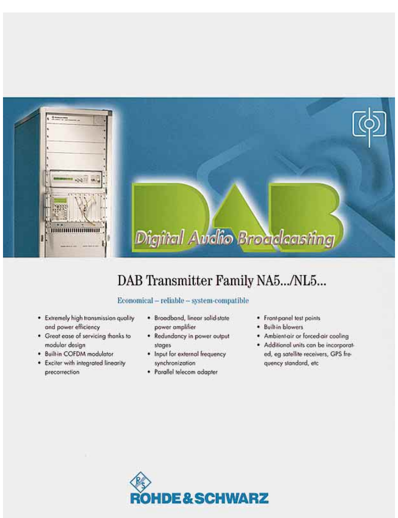
Data sheet PD 757.2515.21 enter 154/19

Jitter and Interface Tester UPD-B22 measures physical parameters of the serial bit stream via the optional AES/EBU interface of Audio Analyzer UPD.

Data sheet PD 757.2750.21 enter 154/20

DAB Multiplexer DM001 is compatible with DAB standard ETS300401 and uses up to twelve audio and data channels to form ETI(NI) or optionally ETI(NA) with 2.048 Mbit/s; FIC generated from internal/external information; option: Reed-Solomon module. **DAB Network Adapter DY001** is compatible with ETS300799 and converts ETI(NA) back into ETI(NI).

Data sheet PD 757.2580.21 enter 154/21

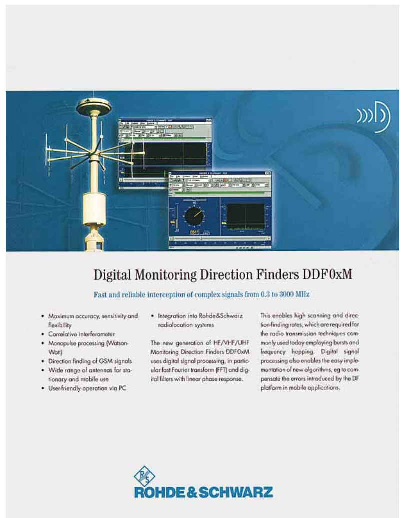


DAB Transmitter Family NA5... (174 to 230 MHz; 250 / 500 / 1000 W) **and NL50.0** (1452 to 1492 MHz; L-band; 100 / 200 / 400 W) The solid-state transmitters for terrestrial digital audio broadcasting are economical, highly reliable and system-compatible (SFN, eg through linking to GPS); built-in COFDM modulator; linearity precorrector; built-in blowers for ambient or external air; IEC/IEEE bus and RS-232 (RS-485) interfaces.

Data sheet PD 757.2573.21 enter 154/22

NICAM Coder/Modulator CT200N2 is a supplement to CATV System CT200 and supplies a second 4PSK(QPSK)-modulated IF sound subcarrier.

Data sheet PD 757.2409.21 enter 154/23



Digital Monitoring Direction Finders DDF0xM (0.3 to 3000 MHz) Among other new features, HF Antenna ADD010 (semi-mobile or stationary, elevation ≤ 50°, limited SSL) is presented.

Data sheet PD 757.1854.22 enter 154/24

Digital Scanning Direction Finders DDF0xS (DDF01S: 0.5 to 30 MHz, DDF06S: 0.5 to 650/1300 MHz) detect complex signals at 200 MHz/s (with 8-kHz resolution); DF error (Antenna ADD051) 1° RMS; Watson-Watt and correlation; stationary and mobile use, system-compatible.

Data sheet PD 757.2173.21 enter 154/25

Airport Communications & DF This brochure highlights the 40 years of experience Rohde & Schwarz has gathered in ATC systems including direction finders.

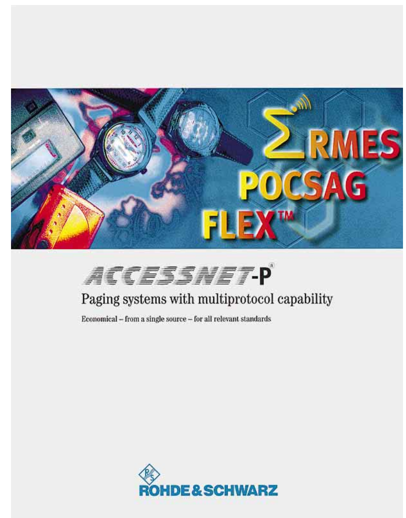
Info PD 757.3111.21 enter 154/26

EMC Test & Measurement Products The English edition of this catalog has been revised and newly published.

Cat PD 757.2350.22 enter 154/27

Paging systems with multiprotocol capability ACCESSNET®-P This brochure from **R & S BICK Mobilfunk** presents economical paging systems for all relevant standards.

Info PD 757.2838.21 enter 154/28



New application notes

Measurements on GSM base stations according to Rec. 11.20
Appl. 1EF23_0E enter 154/29

Measurements on PCS1900 base stations according to J-STD-007
Appl. 1EF24_0E enter 154/30

4-port measurements with Vector Network Analyzer ZVR
Appl. 1EZ25_0E enter 154/31

3-port measurements with Vector Network Analyzer ZVR
Appl. 1EZ26_0E enter 154/32

Frequency conversion measurements with Vector Network Analyzer ZVR
Appl. 1EZ27_0E enter 154/33

Producing epicycloid traces
Appl. 1EZ28_0E enter 154/34

Measurement uncertainties for vector network analysis
Appl. 1EZ29_0E enter 154/35

Automatic calibration of Vector Network Analyzer ZVR
Appl. 1EZ30_0E enter 154/36

Schz

Photo: Beckmann

Consul General of People's Republic of China visits R&S

The People's Republic of China opened its own consulate general in Munich at the beginning of the year, a major reason being the steady growth in business between Bavaria or southern Germany and China and the number of people visiting the country. Besides the usual consular office for visa matters and the like, the consulate general also has a trade department. This is meant to act as a first port of call for German firms and assist them in creating and developing business relations with China.

It was a sign of special esteem when Consul General Liu Guangyao visited Rohde & Schwarz right at the start of his term in Munich. Friedrich Schwarz, who is Honorary Consul of Iceland, welcomed the guest. There were no language problems during their meeting because the Consul General speaks fluent German. He studied German language and literature at Beijing University and has even translated some of Heinrich Heine's works into Chinese.

Following a general presentation of Rohde & Schwarz and a report on its activities in China, the guest was taken on a short tour of the company to see and learn something of the various divisions. He was surprised by the wide ranging product assortment and pleased to hear of the long and good relations between Rohde & Schwarz and his homeland. An entry in the visitors' book and a toast (photo) symbolized the mutual wish to further develop contacts and relations between Rohde & Schwarz and China.

J. Beckmann

12th International EMC Symposium

The highly reputed EMC Symposium in Zurich with its accompanying technical show attracted some 750 participants from more than 30 countries in February of this year to discuss the subject of electromagnetic compatibility. Half of the participants were scientists come to tell of all that is new in their discipline, while the other half were practicians looking for solutions to their problems. The conference offered over 100 technical contributions in the form of lectures, seminars, sessions and special events. With some 70 firms exhibiting, there was even more to see than in recent years. Rohde & Schwarz – represented by the motto *EMC Solutions* on an attractive stand (photo) – was again able to present a world première, the EMI Test Receiver ESCS (see page 7 in this issue). This drew a lot of attention from both visitors to the show and competitor firms.

V. Janssen

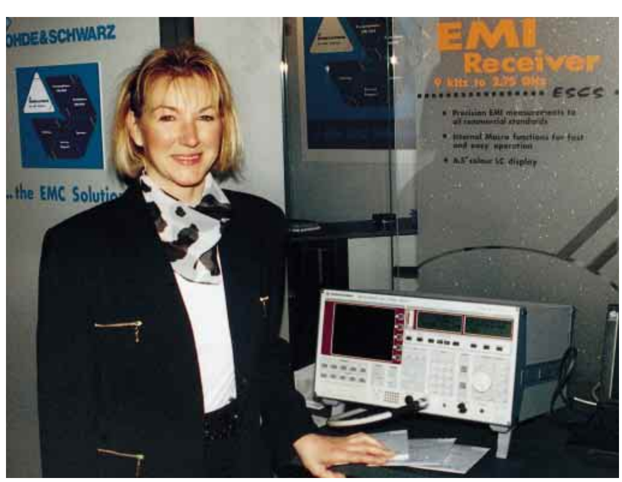


Photo: Janssen

Engine Exhaust Analysis workshop at Rohde & Schwarz

Leading designers of combustion engines met at the end of last year at the Rohde & Schwarz plant in Cologne. The 30 participants were able to learn of a new measuring method as part of a workshop on the subject of engine exhaust analysis. They were acquainted with Airsense 500, one of the most powerful mass spectrometers, a high-speed device offering valuable support in the design and optimization of combustion engines (see News from Rohde & Schwarz No. 151).

Dr. Andreas Wasserburger of Rohde & Schwarz environmental and process measurement engineering and Dr. Johannes Villinger, the designer of the mass spectrometer, presented fascinating measurements from automotive research and development. Possible uses are optimization of the mixture in vehicle engines and optimum design of catalytic converters for exhaust systems. All engine designers work under extreme pressures in terms of competitiveness and cost. Modern measurement technology can help achieve a competitive edge, because fast measurements shorten the time to design and thus cut costs. The presentation of other projects from research and process measurement ended with a lively roundtable, during which experience was exchanged and new possibilities of use were discussed. This event demonstrated once again that Rohde & Schwarz Cologne, with a constant stream of innovations, is a highly competent partner for solving measurement tasks in process and trace analysis.

N. Schuster

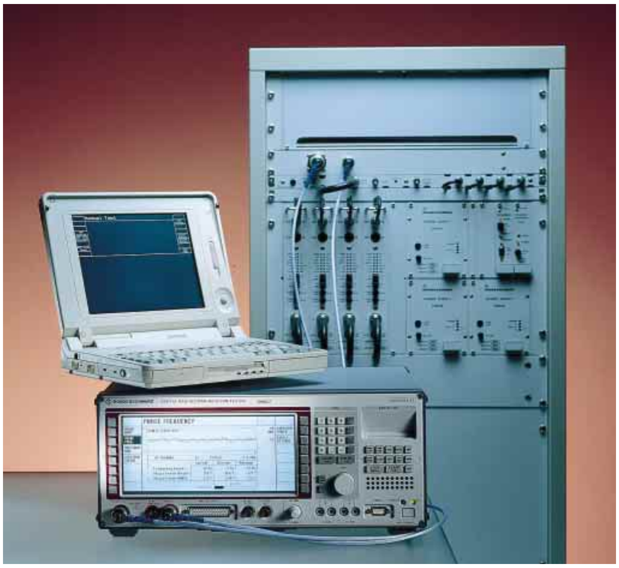
DKD accreditation for Rohde & Schwarz Memmingen

Globalization of markets, stricter product liability legislation and stiffer quality demands as the consequence mean that manufacturers have to show comparable and thus traceable test results for their products. That calls for reliably calibrated test facilities. They are indispensable if the results, directly or indirectly, serve human safety, if damage to or loss of products can be averted, and the dependability of the results has to be guaranteed.

For Rohde & Schwarz's manufacturing plant in Memmingen this has meant, for years already, constant improvement and refinement of its calibration practices to high technical standards. The accreditation awarded last year by DKD (German calibration service) was a logical continuation of its efforts. The strict hierarchic structure of calibration facilities and the use of examined and controllable methods ensure that the individual physical parameters can be related directly or indirectly (through transfer standards) to recognized national or international standards, ie that they are traceable, that the indication produced by a DUT is compared to the standard with known and defined measurement uncertainties (calibration), and that test procedures are conducted in controlled and thus reproducible conditions. Personnel with many years of experience and well-founded specialist know-how were examined in the course of the accreditation, and they are responsible for correct technical handling of calibration orders, not only from within Rohde & Schwarz but also from other producers.

The Memmingen plant is accredited within DKD for the physical variables DC voltage, RF power, attenuation and reflection. Based on these parameters it is possible to calibrate voltmeters and RF power meters for example, RF signal generators, receivers, attenuators and calibration sets for network analyzers. The results are confirmed by a DKD calibration certificate; all non-accredited variables are covered by a works calibration note.

O. Cziha; L. Stuber



Cooperative development of TETRA type-approval test system

Rohde & Schwarz and Tele Denmark have signed a cooperation agreement for the development of a type-approval test system for TETRA units. Rohde & Schwarz will develop the hardware and software components of the system, while Tele Denmark will validate the test cases to run on it. The system consists of TETRA Simulator TS8940 (photo) for RF measurements based on ETSI standard ETS 300 394-1 and a TETRA signalling system that conducts protocol tests to ETS 300 394-2 (see News from Rohde & Schwarz No. 153).

The TETRA simulator is composed primarily of a system controller, signalling platform, I/Q modem, two RF signal generators and a spectrum analyzer, and the TETRA signalling system of a signalling platform and I/Q modem. The TETRA simulator is due to become available to test houses and producers of TETRA units at the end of the year, followed by the TETRA signalling tester early in 1998. During the interval the implementation of the test cases will be validated to ensure that they run correctly. Currently the possibility of an interim type approval is being examined so that TETRA units can be launched on the market this year already. PI

A_{bis} control software for GSM base-station tester CMD54/57

Digital Radiocommunication Tester CMD54/57 (photo) has always been able to test every imaginable kind of base station on the air interface, but the number of models that could be controlled on the A_{bis} interface was limited by special-to-producer interface protocols (see News from Rohde & Schwarz No. 151). New software options (CMD-K10 through K17) now offer all the necessary requirements for convenient driving of base stations from Ericsson, Nokia, Italtel, Nortel/Matra, Siemens, Alcatel and Lucent on the A_{bis} interface. All common interface protocols are supported: E1 (2.048 Mbits) and T1 (1.56 Mbits) including 16-kbit signalling. The application programs contained in each option ensure that all necessary processes work simply and surely. They cover complex manual control for testing individual base-station parts, the IEC/IEEE-bus-controlled test procedure in production and fully automatic testing of an entire base station by CMD in stand-alone mode. W. Dilling

R&S Bick Mobilfunk renovates DeTeMobil paging system

R&S Bick Mobilfunk, the Rohde & Schwarz subsidiary responsible for professional mobile communications, received an order from Deutsche Telekom DeTeMobil to renovate its nationwide paging infrastructure. The latest generation ACCESSNET®-P paging system with multiprotocol capability will be used, which fuses POCSAG and ERMES services on a single system platform. It can be expanded at any time and at low cost by further paging standards like FLEX and APOC. ACCESSNET®-P was optimized throughout for maximum availability and low operating costs. New paging services like SCALL have been a big market success for DeTeMobil, making expansion of the existing system necessary. Seeing as DeTeMobil is also the winner of an ERMES license, it has chosen in ACCESSNET®-P a system that unites all services on one system platform and consequently allows high utilization of the access and central office technology. Calls are distributed inexpensively to the individual paging transmitters by satellite. PI

Expansion of Rohde & Schwarz executive

As of 1 January 1997 Michael Vondermassen, Dipl.-Ing., Dipl.-Oek. (39) joined the Rohde & Schwarz executive, assuming at the same time management of the Sound and TV Broadcasting Division.

Michael Vondermassen was born on 21 May 1957 in Hagen in Westphalia. After studying communications – specializing in microwave engineering – he joined Rohde & Schwarz in 1981 as a specialist in computer-aided PCB design and from 1986 onwards concentrated on setting up inhouse CAD training. From 1991 to 1993 he took part in a promotion scheme for managerial personnel. During this time he was head of CAE and CAD coordination and user support and also found time to study economics in Zurich. In 1993 he became personal assistant to the Executive Vice President of the Central Technical Services, Production and Materials Management Division and in the same year was appointed President of Rohde & Schwarz FTK GmbH in Berlin, an R&S subsidiary that focuses on FM broadcast transmitters and RF power amplifiers. In May 1995 Vondermassen became President of SIT, likewise an R&S subsidiary and also in Berlin, which offers consulting and security analysis for industry and public authorities and develops crypto products for the protection of information in modern communication systems. PI

Analog/digital go-between

The international hifi magazine *Stereoplay* looked at the subject of digital measurements in its January issue, using Audio Analyzer UPL from Rohde & Schwarz for the purpose:

Audio Analyzer UPL from Rohde & Schwarz also allows jitter analysis of a kind and precision unknown before. …It is difficult to tell by the conventional method exactly what kind of interference leads to differences in sound. Noise or sinusoidal jitter can be recognized as such from the histogram, but not fineness of structure. This is where *Stereoplay's* new Audio Analyzer UPL (from Rohde & Schwarz) comes in. The lab uses it for highly precise measurements of analog signals and analyzes digital data not only for their information content but also for clean timing.

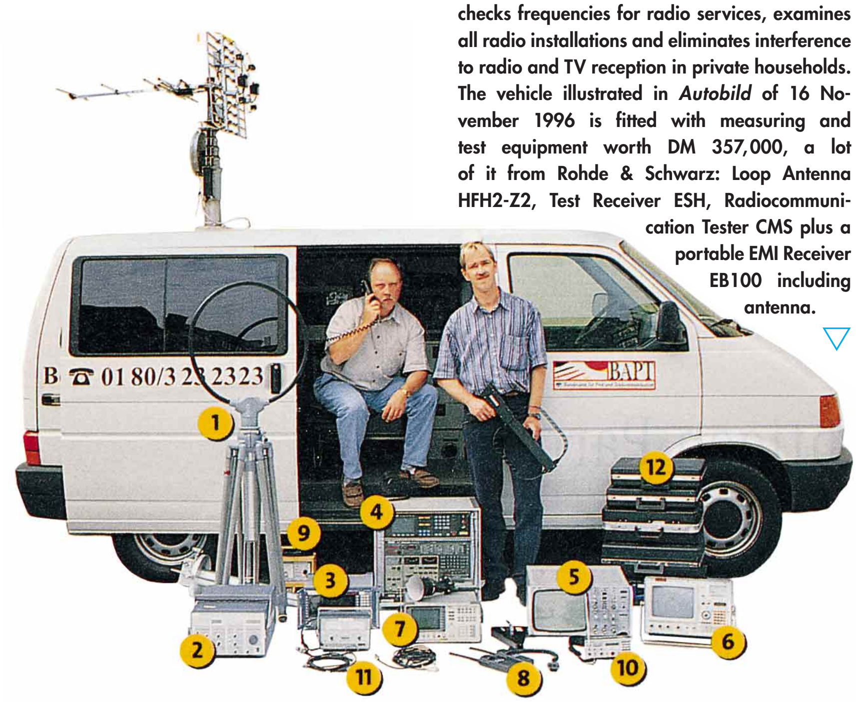
New R&S showings mirrored in the press

During the Munich electronica 96 show, Rohde & Schwarz staged a press conference to present the new PSP and LV2. *Elektronik-Praxis* reported in issue 1/97:

"The mobile Industrial Controller PSP finally makes measurement and control portable", is how product manager Dietmar Vahldiek summarizes the advantages of the new Rohde & Schwarz process controllers. They are intended to meet the increasing demands in systems engineering for simple and flexible integration of instrumentation plus clear and easy evaluation of results. And the real highlight, emphasizes Vahldiek, is that "because of their compact design and battery powering, the user can measure automatically whenever and wherever."

Among its production testers Rohde & Schwarz has upgraded the optical LaserVision board testers: "LV2 now gives you extra test possibilities and a higher testing rate", are the major improvements named by product manager Klaus Kundinger. …"Compared to other optical test systems on the market, LaserVision offers exceptionally high fault detection at an extremely low pseudo error rate", emphasizes Kundinger. The test rate of at least 10 components per second matches the speed of modern placement machines. "So", says Kundinger, "that enables direct use for process control on a production line."

The grey transporters of the German Post and Telecommunications Office (BAPT) are probably the least known government vehicles on the nation's roads. The new office, created after the postal system reform in 1990, issues and checks frequencies for radio services, examines all radio installations and eliminates interference to radio and TV reception in private households. The vehicle illustrated in *Autobild* of 16 November 1996 is fitted with measuring and test equipment worth DM 357,000, a lot of it from Rohde & Schwarz: Loop Antenna HFH2-Z2, Test Receiver ESH, Radiocommunication Tester CMS plus a portable EMI Receiver EB100 including antenna.



GSM/DCS Go/Nogo Tester CTD55 first in class

The response was enormous when electronic communications magazine *Funkschau* called on its readers to choose the product of the year for 1996. The results were published in the 1/1997 issue:

Readers were able to vote for their favourites from a list of suggestions divided into nine categories. GSM/DCS Go/Nogo Tester CTD55 from Rohde & Schwarz had its nose in front in the test category, crossing the line before a Siemens unit (15.4%) and voted product of the year with a big lead (30.7%).

Secure telecommunications

Number 4/1997 of *Funkschau* looked at the subject of industrial espionage, concluding in its report that the damage, amounting to millions, could be prevented by the right measures and focusing on the advantages of the ComSave Box from SIT:

Data lines can be secured by the ComSave Box from Gesellschaft für Systeme der Informationstechnik (SIT), a subsidiary of Rohde & Schwarz. The unit is connected straight to the modem of a computer or plugged into the RS-232-C interface to encrypt the information flow at a rate of up to 115,200 bit/s. It is intended among other things for secure data transmission in telejobs.

Swiss rail's new radio measurement carriage: heading for the future

Train radiotelephony has for long been an indispensable part of railway traffic. This important means of communication differs from other radio networks mainly in that good coverage is required only along the railway track and that there is no need for area coverage like with a mobile-radio network. Train radiotelephony is not only a communication medium but also part of a safety network so that it must satisfy special requirements regarding availability and quality. This is where measurements come in to provide under realistic conditions an accurate and reproducible survey of the high-frequency environment so that gaps in the coverage can be filled. Realistic can mean only one thing: measurement on all frequencies from the moving train – at its usual speed of course.

Swiss Railways (SBB) had begun back in 1986 to test the quality of radio coverage in the suburban railway system of Zurich. Test platform was a scrapped carriage that was fitted out for the installation of the necessary basic measuring instruments at a minimum of outlay. Originally it was intended for project planning of the train radio system, but experience of the following eight years showed the importance of measurements during the construction phase and after commissioning of a line. The radio measurement carriage thus became an indispensable aid in acceptance testing (quality assurance). In summer 1993 this first radio measurement carriage was beginning to show its age however; damage to the body due to rusting made a speed limit of 100 km/h necessary. Moreover, the modest measurement facilities no longer fulfilled the grown requirements – every second measurement proved to be inadequate for some reason or other.

FIG 1 New radio measurement carriage of SBB, a passenger coach totally renovated and reconstructed at SBB main workshop Zurich-Olten: with speeds of 160 km/h, three simultaneous frequencies and 1st-class measuring convenience
Photo: Roschi Telecommunication AG

FIG 2
Interior view of measurement carriage with test receivers, modulation analyzers and monitors
Photo: Roschi Telecommunication AG

After detailed planning utilizing all the experience gained over the years, the construction of a new radio measurement carriage on the basis of a modern passenger coach of type RIC Bm (FIG 1) began in May 1994. Following total renovation of the carriage and constructional changes, **Roschi Telecommunication AG of Ittigen, the general agent of Rohde & Schwarz for Switzerland,** was awarded a contract for the supply and installation of the measuring equipment. Roschi already had sufficient experience in this field, gained in the maintenance of the measuring equipment in the previous radio measurement carriage. What is outlined here in a few words was in fact a long list of requirements that had to be met. Some of the requirements: the error of the distance measurement for instance should be much smaller than 0.1% (which means 130 m with a test route of 130 km); definitions of test routes, measurement parameters and analysis should not mutually affect each other; new results obtained in periodic checks should be comparable online with the old ones, etc. Top performance is expected of the board computer; it should furnish a large quantity of data without delay despite the high measurement rate. By contrast, requirements for redundant power supply or air-conditioning – because of the measuring instruments – were relatively modest.

FIG 3 Onboard equipment includes radio coverage measurement instruments as well as Radiocommunication Tester CMT54 (background)
Photo: Rockrohr

The number of **measuring instruments** is impressive (FIG 2): three Test Receivers ESVD, two Selective Modulation Analyzers FMAS, one Spectrum Analyzer

FSA and one Test Receiver ESVP dominate the scene. A rooftop antenna is available for each frequency band and connected automatically depending on the respective measurement. The test results can be output on a colour printer in up to DIN A3 format. Thanks to intelligent firmware, the use of Test Receivers ESVD reduces the amount of measurement enormously: in measuring the field-strength profile of the track each of the test receivers – triggered by a timebase or distance measuring system – can furnish up to 7000 values per second. The distance measuring system generates a clock pulse every 10 cm. Two axles of the SBB radio measurement carriage are fitted with such a system; moreover, doppler radar is used. The uncertainty of distance measurement is less than 0.05% in practice and the system works fine up to a speed of 230 km/h, although the measurement carriage has only been approved for speeds up to 160 km/h. Since the two modulation analyzers and the three test receivers operate under computer control during the measurement, manual intervention on the part of the operator is not possible. To obtain information however, Test Receiver ESVP and Spectrum Analyzer FSA allowing manual control are also part of the equipment onboard.

For analysis of the received radio signal the field strength alone is not sufficient so the signal quality must also be evaluated. This is where Modulation Analyzer FMAS comes in, performing signal analysis of the three received radio channels as to distortion and frequency deviation. From the online display of the graphically evaluated analysis the quality of the radiotelephony announcements can conveniently be checked. To allow subsequent identification of any striking features in the frequency plot with reference to the test route, a video camera installed in the engine takes pictures of the environment during the test tour. Picture and demodulated AF signal are recorded by a video system and all parameters relevant for the test tour are superimposed on the picture by a video processor. Should mobile video processing become necessary, this is not a problem either: the carriage is equipped with several video recorders plus appropriate cutting computers.

Even the observer with a technical background is impressed when walking through the new measurement carriage. Everything is immaculately installed, there is nowhere a cable lying around that might disturb this orderliness. Any equipment that might prove to be useful some day finds its place. A cordless telephone and/or Natel mobile phone can be picked up at the door of each test compartment so that communication will not be interrupted on leaving the carriage (an orange warning vest must be worn). The compartments are interconnected with all kinds of RF, data and AF lines. A spare unit is available for each of the key instruments, stored in a custom aluminium case in the large workshop compartment. Should one of the numerous train radiotelephones require service or break down, the remedy is there for the taking: Radiocommunication Tester CMT54 from Rohde & Schwarz is on board too (FIG 3). Needless to say, the espresso machine in the neat kitchenette is one of the very best.

Switzerland is a picturesque country and so during this test tour we were again and again tempted to ignore the monitors with their mass of information and to view the scenery instead, all the more since measurements are automatic anyway. While the test tour is furnishing a large amount of results, the onboard computer converts them into readable format, eg into a colour DIN A3 plot with the exact field-strength characteristic of three frequencies over an accurately defined route section (FIG 4). This new "jewel" of SBB has been in operation since late 1995 for measurements on their train radiotelephone networks and not a single result has been lost. And the best comes at the end: the job is completely done at the end of the test tour, all that remains is to switch off and get off the train. It's a pity, we really should have looked out of the window more often.

Christian Rockrohr

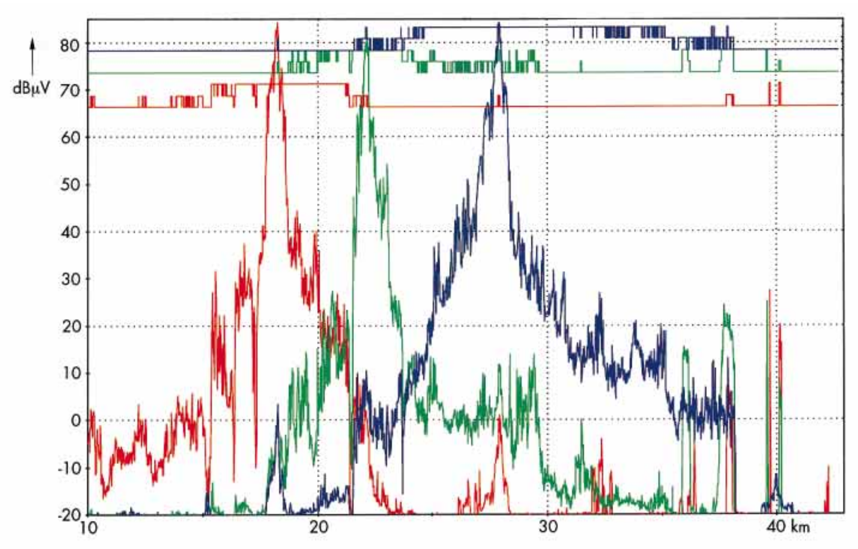


FIG 4 Field-strength profile measured on route Escholzmatt – Luzern between kilometer 10 and 40 at frequencies of 457.875 MHz (red), 457.575 MHz (green) and 457.500 MHz (blue)

Reader service card 154/37 for further information on train radio measurement systems

Visit us on Internet under www.rsd.de

ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München
P. O. B. 80 14 69 · D-81614 München · Tel. (+49 89) 41 29-0 · Fax (+49 89) 41 29-21 64

News from Rohde & Schwarz 154 (1997/II) · PD 757.2780.21 · B42622